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Environmental Due Diligence for Project Selection in Research & Technology Development Organizations

by

Daphne Belva Cheel ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial
fulfillment of the requirements for the degree of Master of Science

in

Environmental Science

Department of Civil Engineering

Edmonton, Alberta

Fall 1995

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Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Environmental Due Diligence for Project selection in Research & Technology Development Organizations submitted by Daphne Belva Cheel in partial fulfillment of the requirements for the degree of Master of Science in Environmental Science.

Dr. Steve Hrudey

Dr. Steve Stanley

Dr. W.V. Adamowicz

DEDICATION

To my three "K'"s:

Ken, for the love and moral support;

Kaitlin and Kelsey, for showing me why.
May you both learn to understand and appreciate the balance.

ABSTRACT

We currently live in a society that expects all organizations to conduct their affairs in an environmentally responsible manner. To be able to fulfill this expectation, organizations require processes and tools that explicitly include the environment in decision-making and in day-to-day operational activities. The focus of this work was development of processes and tools that addressed this need in an organization that faces a changing domain of environmental concerns. The process developed by this thesis provides a method for systematically identifying potential environmental risk and liabilities for diverse types of projects prior to making investment decisions. This was accomplished by first identifying the different ways a project attracts risk to an organization, and second by identifying the sources of environmental liability for an organization. The applicability of the process was demonstrated through the use of case studies. The environmental risks and liabilities identified by the process for each of the case studies were those that would be considered reasonable and foreseeable.

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1. PROBLEM STATEMENT

Research and technology development organizations need to operate and conduct their activities in a manner consistent with societal expectations. In the forefront of these expectations is that all organizations will behave in an environmentally responsible manner. At jeopardy by inappropriate behaviour in this area is the overall viability of an organization. Recognizing this financial reality, considerable effort has been expended in the fields of environmental management and environmental product design. This work, however, is not directly applicable to research and technology development organizations because it has not adequately addressed the dynamic range of environmental issues that are unique to this type of organization.

Research and technology development organizations are fundamentally different from other organizations that develop processes and products. It is the essence of research and development to be doings things not done before, and in an environment with unknown boundaries. On the other hand, other organizations, such as manufacturing firms have development activity in an environment for which they seek to define clear and consistent boundaries. The boundaries of an organization is an important element that needs to be considered when establishing an organizational environmental management system (EMS). It defines the domain of environmental concerns that will need to be addressed by the organization. Generally speaking, the domain of environmental concerns for an organization with well-defined boundaries tends to change very little. As a result, the diagnosis and definition stage in EMS development is tends to be straightforward, with the bulk of the effort focused on implementation and operational optimization concerns. In a research and technology development organization, however, the domain of environmental concerns potentially will change with every project it undertakes. The stage of diagnosis and definition in EMS development is continuously being revisited with each new project undertaken. This different emphasis in EMS's between organizations with well-defined boundaries (i.e., manufacturing) and organizations with undetermined boundaries (i.e., research and technology development) can be demonstrated using a simple model (Figure 1.1).

The EMS within the research and technology development organization needs to address and take into account this changing domain of environmental concerns. A key process within the EMS for this type of organization will be how and when to redefine the domain. Generally speaking, the domain changes in response to investment choices in activities/projects. Therefore it is important to make these choices with full knowledge of what the environmental risks and liabilities of development might be, up front. By doing so, the research and technology development organization would be:

- managing its environmental risks in a manner that can achieve "bottom line" benefits,
- increasing the value of its products,
- acting in a manner consistent with the environmentally-related expectations of society.

▨	**Diagnosis & Definition**	**Implementation**
Narrow, Static Scope	▨	Focus & Optimization
Broad Changing Scope	Focus & Optimization	▨

Figure 1.1 A simple model demonstrating the difference in EMS emphasis between organizations that have different scopes in environmental concerns domains.

1.1 Objective

The focus of this work is development of a system that defines, for a research and technology development organization, its changing domain of environmental concerns. Specifically, this work is directed at the processes necessary to identify the potential environmental risk and liabilities associated with a proposed research and development project. In essence the processes need to develop a qualitative inventory of environmental risks for the research and technology development organization if it chooses to invest in a project. In order to accomplish this task a number of questions need to be answered, such as:

- what constitutes an environmental risk or liability,
- how do projects attract environmental risk and liability for a research and development organization, and
- what are the sources of the risks and liabilities?

The answers to these and other relevant questions will provide the framework necessary to define the processes required for proposed system.

2. BACKGROUND

> "The world we created today as a result of our thinking thus far has problems which cannot be solved by thinking the way we thought when we created them."
>
> ...Albert Einstein

Traditionally, human endeavours or activities have not included consideration of the environmental consequences of an activity. As a result of this failure to include of environmental consequences, human activities have led to environmental contamination, pollution, and waste management problems. Initially, the response to obvious environmental pollution has been for government, regulatory agencies, and industry to design "end of pipe" and media-specific solutions to the problem. This response really didn't address the generation of pollution by industrial processes and products, but rather tended to transfer the pollution from one form to another, or from one media to another. To truly reduce the burden of human activity on the environment, fundamental changes to industrial processes, products, and human decision-making processes were required. This change in thinking around the interaction between human activities and the environment has begun and has been called the sustainable development paradigm (WCED, 1987).

Essentially, the sustainable development paradigm requires that human activity strike a balance between four overlapping and competing areas of responsibility or feasibility (Figure 2.1). These are the areas of economic feasibility, technological feasibility, social feasibility (or consequence) and environmental feasibility (or consequence). The first two of these areas or

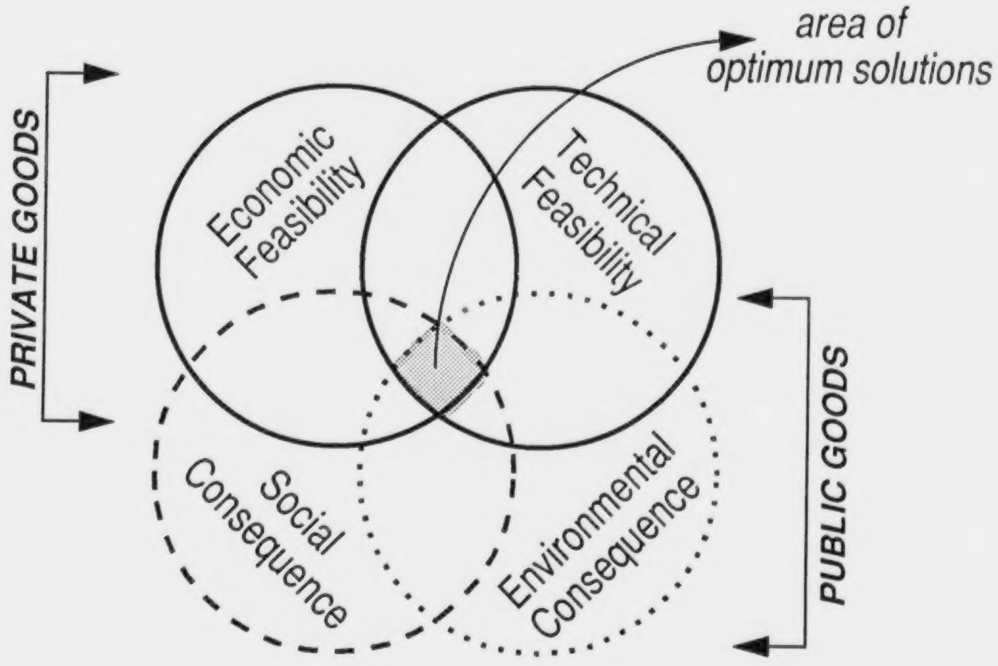

Figure 2.1 Activity evaluation framework. Human activities need to strike a balance between the factors of economic, technological, social, and environmental feasibility.

factors (economic and technological) have measures that may be classified as objective. In other words, comparisons between activities can be made on a quantitative basis. These factors (economic and technological) are also focused on the "corporate" or private good. On the other hand, the areas of social and environmental feasibility are focused on the public good, and have measures that are considered subjective or qualitative. Because their definitions are fuzzier, the ability of social and environmental factors to influence decision-making has been problematic. In the past, the focus of human activity has been on optimization of the economic and technological factors, with the historical result of environmental degradation on the local, regional, and global scales. It is now recognized that engaging in activity that does not attempt to balance all of the factors – economic, technical, social and environmental – is not sustainable in the long run (WCED, 1987).

Society, industry, and professional groups have recognized this need for balance, and each have taken steps to begin evaluating human activities in this context. Society's response has been reflected in the development of new and more stringent laws with the emphasis on environmental protection. It is society's expectation that industry, companies, and organizations that provide consumer products will do so in a manner that is consistent with a balanced approach, that they will exercise appropriate due diligence in all aspects of their business affairs. Industry's response has lead to the use and development of environmental management systems (EMS), in the proliferation of codes of practice and environmental guiding principles, and in the development of the industrial ecology concept and product-focused environmental design methods. Finally, professional organizations have also realized the role they play in achieving activity solutions that reflect a balanced perspective. Their response has lead to the development of codes of practice for their members (i.e., APEGGA, 1994). It is worth exploring further what is entailed in several of these responses, as the exploration will help formulate answers to the questions posed in the objective, and generate new questions to be resolved.

2.1 Environmental Due Diligence and Environmental Liability

> "Environmental awareness among the public ensures that virtually every legal entity in our society has some level of environmental liability exposure"
>
> ...L.B. McCarten

To better understand what is meant by environmental due diligence and environmental liability, or what constitutes an environmental liability, four terms require clarification: what is meant by environment, what is meant by due diligence, what is meant by liability, and what constitutes an environmental law. The following discussion first addresses each of these questions and then expands and discusses the sources of environmental liability

In determining what is meant by the environment, the Alberta Environmental Protection and Enhancement Act (AEPEA) and the Canadian Environmental Protection Act (CEPA) provide the following definition:

> "environment" means the components of the earth and includes
>
> (i) air, land and water,
>
> (ii) all layers of the atmosphere,

(iii) all organic and inorganic matter and living organisms, and

(iv) the interacting natural systems that include components referred to in subclauses (i) to (iii).

Or, to put it more succinctly, as Franson (1992) does:

> "... the term environment includes the interlocking web of plants, animals and resources, and the associated flow of energy from the sun and from one form to another, that make up our life-support system."

In other words, environment is an encompassing term, and humans and human activity are integral parts of it.

The term "due diligence" is a concept that has evolved in the legal arena as a defence against a branch of offences called strict liability offences. The category of strict liability offences, also known as public welfare offences, requires no mental element to the offence, only proof that the act was committed (Meadows, 1993). Most environmental offences are strict liability offences unless the statute creating the offences contains words such as "willfully", "with intent", "knowingly" or "intentionally" (Meadows, 1993). Environmental legislation at the federal level in Canada and at the provincial level in the Province of Alberta allows for both criminal offences (act + mental element) and strict liability offences. This legislation also allows for the due diligence defence in the commission of strict liability offences (s. 215, Alberta Environmental Protection and Enhancement Act, Chapter E-13.3, 1992; s. 125, Canadian Environmental Protection Act, 1988).

What is actually meant by due diligence is best presented as a quote from the sentencing decision in R. v. City of Sault Ste. Marie (1978) [one of the landmark cases in environmental law in Canada]:

> "The defendants must establish on the balance of probabilities that they were duly diligent, that is, they must establish that they exercised all *reasonable care* by establishing a *proper system* to prevent the commission of the offence and by taking reasonable steps to ensure the *effective operation of the system*" (emphasis added).

This decision indicates that there are three elements that must be present to establish that due diligence existed prior to the commission of an offence: that reasonable care was used, that there was a system in place to prevent what had happened, and that reasonable steps were taken to ensure that the system operated (Moen, 1995). However, what exactly constitutes reasonable care, and thus due diligence will be situation-dependent. In a given set of circumstances, it will depend on what would be considered reasonable and foreseeable (notions from the legal realm of "negligence"). In addition, a system of due diligence needs to consider and include pro-active elements – mere compliance has not been considered sufficient by the courts in cases of environmental offences (R. v. Bata Industries Ltd., 1992). It has been suggested that environmental due diligence should not be considered just a defence against prosecution for environmental offenses. It should be considered a "frame of mind", or a corporate philosophy or conscience around doing business (Moen, 1995).

Turning to liability, the term liability is defined in the Canadian Law Dictionary (Yogis, 1990) as:

1. an obligation to do or refrain from doing something,
2. a duty that eventually must be performed,
3. an obligation to pay money,
4. money owed, as opposed to an asset, and/or
5. responsibility for one's conduct, such as contractual liability, tort liability, or criminal liability.

More succinctly, liability may be considered a consequence, generally negative, of action or inaction. Thus, when combining liability with environment, environmental liabilities may be considered the negative consequences of failure to comply with the requirements of environmental laws and regulations (Arbuckle, 1993). The types of liabilities or consequences that may arise include fines, criminal penalties, and civil remedies such as cost recovery.

What constitutes an environmental law? Probably the best definition of environmental law is that by Thomas Sullivan (1993):

> "... Environmental law is best defined–not as a book or compilation of certain laws, but instead, as a system for using all of the laws ... in our legal system to minimize, prevent, punish or remedy the consequences of actions which damage or threaten the environment, public health and safety."

He goes on further to define the sources of environmental law as:

1. laws: federal and state statutes and local ordinances,
2. regulations promulgated by federal, state and local agencies,
3. court decisions interpreting these laws and regulations
4. the common law,
5. United States Constitution and state constitutions, and
6. treaties (Sullivan, 1993).

Although his discussion is focused on the United States judicial system, given the common roots between it and the Canadian judicial system, it is a relevant and germane interpretation of environmental law in Canada as well. In Canada, environmental law encompasses similar sources as the American law, specifically: legislative Acts and regulations, court interpretations of the statutes, common law, the Canadian Constitution Act, and treaties (both domestic and international).

Given that environmental law is in fact a system of law that encompasses a broad cross-section of the body of law, it follows that environmental liability may arise through the violation of common (tort) law (civil liabilities), or statute (regulatory) law (statutory liabilities).

2.1.1 Common (Tort) Law and Civil Liabilities

Common law is:

"the system of jurisprudence, which originated in England and was later applied in Canada, that is based on judicial precedent rather

> than legislative enactments. (It) depends for its authority upon the recognition given by courts to principles, customs, and rules of conduct previously existing among the people."
>
> ... Canadian Law Dictionary (Yogis, 1990).

"Tort" is the word used to denote a common law civil wrong for which a court will provide a remedy (Sullivan, 1993; Canadian Law Dictionary). A tort arises from the existence of a generalized legal duty to avoid causing harm to others, through acts of omission, as well as of commission (Sullivan, 1993). In the Canadian judicial system this translates into civil litigation. Civil litigation may arise as a result of nuisance, trespass, strict liability, negligence, or violation of riparian rights. These terms, as used in the legal context of common law, are defined in Table 2.1. Any of these may be used to bring a cause of action that may be considered a civil environmental litigation, the resolution of which may lead to an environmental liability. This type of litigation has sometimes also been referred to colloquially as "toxic torts".

2.1.2 Statute (Regulatory) Law and Statutory Liabilities

Statute law or regulations may be formed by any level of government: federal, provincial, or municipal (in the form of by-laws). From the constitutional division of powers and the pervasive nature of what constitutes environmental regulation, the federal and provincial governments share the responsibility for the regulation of the environment (Tidball et al., 1993). The kinds of laws that constitute statutory environmental law are those that are aimed principally at the

Table 2.1 Definition of terms that in a legal context may result in civil environmental litigation (after Moen, 1993; Cotton and McKinnon, 1993).

Term	Definition
nuisance	• unreasonable interference with the use and enjoyment of land by its occupier or with the use and enjoyment of a public right to use and enjoy public rights of way. • a condition and not an act or a failure to act on the part of the person responsible for the condition (Sullivan, 1993).
trespass	• direct and intentional interference with another's property without lawful excuse or justification.
strict liability	• the escape of a substance from land which causes injury, the natural consequence of keeping the substance on the land.
negligence	• an unreasonable risk of harm to a person which results in injury to that person to whom a duty of care is owed.
riparian rights	• the right to water in its natural state and the use of that water

protection of the natural environment (Franson, 1992). Statutory environmental laws can be furthered classified into four broad categories (Franson, 1992):

- laws or regulations that regulate potentially harmful conduct (i.e., waste handling, control of waste production, and direct environmental damage prevention);• laws or regulations that encourage the development of alternative technologies (i.e., fiscal measures such as direct grant programmes and tax rebates for expenditures on pollution control equipment);
- laws or regulations that are designed to produce the information needed to make sound environmental management decisions (i.e., environmental impact assessment laws); and
- laws or regulations that seek to compensate people harmed by environmental degradation.

Statute law yields a complex framework as a source for environmental liability. Coupled with this complexity is the dynamic nature of the framework. It is undergoing constant modification, reflecting the importance that society in general has given environmental concerns. The recent changes to federal and provincial (Alberta) statutes has resulted in increases in the scope of liability for environmental damage caused by companies and individuals (Huestis, 1993). For example, fines up to $1 million per day and up to two years imprisonment are possible under the Alberta Environmental Protection and Enhancement Act for environmental violations. It is the intent of the changes to make environmental protection a consideration in corporate management and decision-making processes at the senior-most levels of a corporation (Cameron, 1993). Within the context of this regulatory environment, devising and adopting strategies to properly manage the environmental portfolio, to establish corporate, institutional, and personal due diligence or care, is of great significance (Donahue, 1994).

2.2 Environmental Management Systems

The trend today is clearly towards greater accountability for environmental consequences of corporate action. Corporate management action to address and manage this accountability has resulted in the development of management systems that make explicit the inclusion of environment in corporate decision-making processes. This type of management system has been termed an Environmental Management System (EMS). Formally, an EMS may be defined as a structured management system, integrated with overall management activity, and addressing all aspects of desired environmental performance (Davies, 1994). An EMS comprises procedures, roles, and responsibilities to ensure that the organization performs in accordance with the organization's environmental policy, which at a minimum means compliance with relevant environmental statutes. A truly effective EMS, however, encompasses a broader environmental goal than just compliance with regulations. Proactive environmental management means responsively addressing business and social obligations to protect the corporation and the environment – and means more that just staying out of jail (Donahue, 1994).

Environmental management systems within corporations (both in Canada and in other nations worldwide) are at varied stages of development – from Stage 1, the "Beginner", to Stage 5, the "Proactivist" (Hunt and Auster, 1990; Warren and Fagg, 1993; Donahue, 1994). A summary of the stages in this model of EMS development (called the Hunt–Auster model) is provided as Figure 2.2. The underlying premise in this model is that companies evolve to become better corporate citizens as their understanding of environmental issues increases, with the initial driving force being regulatory requirements (Fitzgerald, 1995). This approach maintains environmental management as external to, not intrinsic to the organization's core business or to each employee's job responsibilities (Fitzgerald, 1995). To be truly effective, EMS's need to be integrated into the existing management infrastructure of the organization.

In addition to the various stages of development, the techniques and programs used by organizations for environmental management are also varied and diverse. Environmental management efforts may be based on a concept as informal as "do the right thing", to one consisting of formal written policies, goals and procedures (Warren and Fagg, 1993). There have, however, been efforts in the last few years to develop standards for EMS's, nationally (CSA Voluntary Standard Z750-94) and internationally (ISO 14000, in draft). These standards outline key elements that constitute an EMS and provide practical advice on implementing or enhancing an organization's EMS. The CSA standard lists the following as key elements in an EMS:

Development Stage	Corporate Approach to Environmental Management (EM)	Performance Objectives	Resource Commitment	Interaction with Key Departments
1 "Beginner"	EM unnecessary	NONE	Minimal	NONE
2 "Fire Fighter"	Address EM only as needed	Resolve problems as they occur	Budget as problems occur	Moderate: legal
3 "Concerned Citizen"	EM a worthwhile function	Satisfy corporate responsibility	Consistent yet minimal budget	Moderate: legal, PR
4 "Pragmatist"	EM important business function	Minimize negative environmental impacts	Generally sufficient funding	High: legal, PR Moderate: Manufacturing Minimal: design
5 "Proactivist"	EM priority item	Actively manage environmental affairs	Open-ended funding	Involvement daily with legal, PR, mfg./prod., design

Figure 2.2 The Hunt-Auster model for developmental stages of corporate environmental management programs (After Exhibit 1; Fitzgerald, 1995).

- *purpose*, a focus on what needs to be done;
- *commitment*, which addresses the motivation of people in the organization to achieve the organization's environmental objectives;
- *capability*, a focus on the resources required to implement the organization's environmental policies; and
- *learning*, which focuses on those aspects of a management system that ensure that the organization is dynamic, capable of reacting to change, and capable of improving processes.

The standard also stresses that the development and implementation of an EMS is a dynamic and evolutionary process (CSA, 1994). In the words of the standard (page xii; CSA, 1994):

> "...the EMS is best viewed as an organizing framework that must be continuously monitored and renewed to effectively direct a company's environmental activities in response to changing internal and external stimuli. Every individual, whether in management or on the shop floor, must assume responsibility for these incremental improvements, which will be achieved only as the result of ongoing efforts to improve purpose, commitment, capability, and learning activities."

EMS's are, in fact, considered a necessary element to a due diligence defence. In the case of R. v. Bata (1992), the court stated the following:

> "Within this general profile, and dependent upon the nature and structure of the corporate activity, one would hope to find remedial

> and contingency plans for spills, a system of ongoing environmental audit, training programs, sufficient authority to act and other indices of a proactive environmental policy".

Obviously, a high standard of environmental management is expected by the Canadian judiciary (Donahue, 1994). This standard can only be achieved and demonstrated if an environmental management system has been adopted within an organization.

2.3 Environmental Codes of Practice

Another response from industry to the increased accountability for environmental consequences of corporate action has been the formulation and development of environmental codes of practice. These codes are the result of initiatives by different industrial sectors to, as the Canadian Chemical Producers' Association's (CCPA) Responsible Care principles state: "our members' desire to be, and seen as, a responsible industry within society". Figure 2.3 is a list of some of the environmental codes of practice and guiding principles that have been developed by industry associations and business organizations, nationally and internationally. The text of these codes has been provided as Appendix 1. What the codes in Figure 2.3 have in common is the intention to instill in their signatories an "environmental ethic". They also stress individual responsibility for ensuring that environmental objectives are met – not only for the organization, but for society as well.

International Chamber of Commerce (ICC)	• Business Charter for Sustainable Development : Principles for Environmental Management
Coalition for Environmentally Responsible Economies (CERES)	• CERES Principles
Canadian Chemical Producers' Association (CCPA))	• Responsible Care
Keidanren (Japan Federation of Economic Organizations)	• Keidanren Global Environment Charter
Business Council on National Issues	• Business Principles for a Sustainable and Competitive Future
European Petroleum Industry Association (EUROPIA)	• Environmental Guiding Principles
National Round Table on the Environment and the Economy (NRTEE)	• Objectives for Sustainable Development

Figure 2.3 Environmental codes and principles that have been developed by various industrial associations and business organizations.

The codes listed in Figure 2.3 have between seven (7) and 16 elements (Appendix 1) that speak to purpose, commitment, capability and learning, which are the key elements of an EMS. The elements of the various codes also address the environmental performance of different aspects of an organization, such as: business operations, business relationships, management commitment, training, products and services, and community and public relations. Generally speaking, these codes provide policy frameworks under which an organization can implement and assess activities with respect to their environmental performance. In some cases they may also define criteria by which the environmental performance of companies may be assessed. However, they generally do not provide prescriptive methods or tools for actually conducting the assessment.

The exception to the last statement is the Responsible Care initiative by the CCPA. In addition to the seven (7) guiding principles, there are six (6) in-depth codes of practice that make up the Responsible Care initiative (Figure 2.4). These codes have considerable detail, and in many cases, the steps necessary to ensure compliance with the code are spelled out. One code from Responsible Care is extremely applicable and relevant for a research and technology development organization – the Research and Development Code of Practice. This code has a section that specifically addresses research and development project approval (Figure 2.5). Note, however, in this case, while providing the framework for "what", this code does not address "how".

Community Awareness & Emergency Response
(CAER)

Research and Development

Manufacturing

Transportation

Distribution

Hazardous Waste Management

Figure 2.4 The Codes of Practice that are part of the CCPA Responsible Care Initiative (CCPA, 1990).

2. R & D project approval

Prior to initiating an R & D project, every member company conducting research and development of new chemicals and chemical products, processes, equipment or applications shall require that:

2.1 protocols and methodology are in place to ensure that health, safety and environmental hazards are identified and evaluated as early as possible, and standards for operations are defined. This procedure applies not only to the research phase but also to pilot plant operations, manufacturing and marketing as they progress. Particular attention is given early to long-term health and environmental effects related to chemicals, chemical products, processes and new uses and the management of associated wastes;

2.2 ...

2.3 potential applications are defined and analyzed for hazards both initially and as work proceeds;

Figure 2.5 The section from the Research and Development Code of Practice, of the CCPA Responsible Care initiative, that addresses R&D project approval (CCPA, 1992).

Professional organizations have also put forward initiatives in this area. Most notably in Alberta is the effort by APEGGA (The Association of Professional Engineers, Geologists, and Geophysicists of Alberta) in developing and promulgating to its members an Environmental Practice Guideline (APEGGA, 1994). Figure 2.6 is a summary of the guidelines that make up the APEGGA Environmental Practice Guideline. As with the business and industrial codes of practice discussed previously, the intention of this guideline is to instill into its professional ethic an environmental component. This guideline puts the onus on each member for understanding how their field of expertise interacts with and affects the environment. It puts responsibility for the environment squarely on the individual's professional shoulders.

2.4 Industrial Ecology and Product Design

> "...if one takes a more fundamental, preventive approach to the problem of environmental quality by recognizing that it is inherent in the design of production technology, it is possible to find ways of improving *both* the environment and the economy."
>
> Barry Commoner *in*
> Making Peace with the Planet (1990)

The sustainable development paradigm maintains that the needs and aspirations of the present be met without compromising the ability to meet those of the future (WCED, 1987). To respond to the challenges inherent in this paradigm, a new way of thinking about economy–environment interactions has been developed. This new way of thinking has been called the industrial ecology concept. Industrial ecology may be defined as:

GUIDELINE SUMMARY

Professional Engineers, Geologists and Geophysicists;

1. Shall develop and maintain a reasonable level of understanding of environmental issues related to their field of expertise.
2. Shall use appropriate expertise of specialists in areas where the member's knowledge alone is not adequate to address environmental issues.
3. Shall apply professional and responsible judgment in their environmental considerations.
4. Shall ensure that environmental planning and management is integrated into all their activities which are likely to have adverse environmental impact.
5. Shall include the costs of environmental protection and/or remediation among the essential factors used for evaluating the life-cycle economic viability of projects for which they are responsible.
6. Shall recognize the value of waste minimization, and endeavour to implement the elimination and/or reduction of waste at the production source.
7. Shall comply with legislation, and when the benefits to society justify the costs, encourage additional environmental protection.
9. Are encouraged to work actively with others to improve environmental understanding and practices.

Figure 2.6 A summary of the individual guidelines that make up the APEGGA Environmental Practice Guideline (APEGGA, 1994).

> "...the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural, and technological evolution. (It) requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimized include resources, energy, and capital" (Graedel and Allenby, 1995).

In more succinct terms, it is the systematic study of the interactions between the human economy in all its aspects and natural biological, chemical and physical systems at all scales (Chittick, 1993). The goal of industrial ecology is the restructuring the technological basis of our entire economy to make it sustainable over the long haul (Chittick, 1993). In order to achieve this goal, industrial ecology requires:

- a comprehensive, systems-based, multidisciplinary approach; and
- integration of environmental considerations into all technology and economic behaviour (Chittick, 1993).

Industrial ecology provides the framework and context within which sustainable solutions can and will be developed. A unique point of high leverage to institute change, which exists within the industrial ecosystem, is the design of products and processes (OTA, 1992).

The environmental impacts of a product, process or service across its lifecycle are primarily determined in the design stage (OTA, 1992; Chittick, 1993). The failure of current design practices to incorporate a systems approach contributed to the environmental dilemmas we face today (Allenby, 1992). By integrating environmental considerations into product and process engineering design procedures, new environmental dilemmas can be avoided. This design philosophy is an application of the principles of industrial ecology, and has been coined "Design for Environment" (DFE) (Allenby, 1992). DFE builds on, but goes further than, existing "state-of-the-art" concepts such as pollution prevention, waste minimization, and life cycle assessment (Allenby, 1992).

The tools for this nascent field are not currently well formulated, but it has been suggested that DFE methodologies cannot be implemented by private firms without the creation of a "DFE infrastructure" consisting of a number of necessary items, including (but not limited to):

1. comprehensive data sets of relevant information from a wide variety of industry sectors,
2. socially accepted risk prioritization schemes and methodologies,
3. decision rules for value and ethical judgments, and
4. appropriate modification of existing regulatory and statutory requirements (Allenby, 1993).

In practice, the application of the principles incorporated in DFE may involve utilization of the methodologies of several other fields (Fiksel, 1993), such as:

1. life-cycle assessment (a cradle-to-grave analysis of the flows of energy and materials throughout the life cycle of a product);
2. risk analysis (a process that includes hazard identification, risk assessment, determining the significance of risks, and risk communication [Cohrssen and Covello, 1989]);
3. concurrent engineering (a multifunctional approach to product development that uses multidisciplinary teams at each product stage, which reduces product cycle times and results in superior quality products);
4. environmental audit , and
5. environmental impact assessment.

Ultimately, DFE has as its goal the optimization of a product's environmental performance.

2.5 Summary

The term "environmentally responsible", with respect to corporate activity, has been well defined by several elements within society. As a result, what constitutes an environmental risk and liability for any corporation can be identified. The scope of activities within an organization can be used to extract potential risks and liabilities from the environmental law framework. Also well-defined, at least in principle, is the standard(s) by which corporate activity will be judged. While aspects of what constitutes environmental due diligence can be likened to "drawing lines in the quicksand" (Meadows, 1993), the concept of reasonableness and foreseeability will remain key elements.

The proliferation of environmental guiding principles and codes of practice demonstrate that corporations, world-wide, do understand the need to include environmental considerations in how they do business. Managers of organizations recognize the very real financial consequences of being environmental "bad actors". The codes and guiding principles, however, while instilling in their signatories the need for an environmental ethic, do not provide the tools by which the corporations can achieve compliance with the code. Implementation of the codes has led to the development of two areas of application or focus:

- environmental management systems, with the work to date focusing on optimization of the environmental performance of operational activities (i.e., hazardous waste minimization, energy conservation, regulatory compliance, etc.); and
- environmental product design, with the work focusing on optimization of the environmental performance of individual products.

What has not been demonstrated in the literature are the protocols and methodologies needed to optimize the environmental performance of decision-making processes, especially those dealing with project selection in research and development organizations. Specifically, the protocols and methodologies needed to fulfill the objectives of Section 2. of the Research and Development Code of Practice of the CCPA Responsible Care initiative (Figure 2.4) have not been fully realized. This remains as a development need.

Three questions were posed in the objective statement for this work. The literature adequately address two of them, specifically, what constitutes an environmental risk and liability and the sources of the risks and liabilities. What remains to be identified is how projects attract risk for a research and development organization. In conjunction with this, further questions arise:

- how should the risk source information be structured to support project selection processes; and
- how are projects selected for investment within research and technology development organizations?

3. STUDY DESIGN AND METHODOLOGY

To define processes for a system that is responsive to a research and technology development organization's needs to be environmentally responsible in all aspects of its operations, answers to the unresolved questions posed in the preceding material are required. As well, the study design must also consider the practical needs of this type of organization. Any system developed needs to be compatible with other systems and processes that exist within the organization. Incorporation of these considerations into an overall process resulted in the following study design:

- *selection of a research and technology development organization.* Using a real existing corporate entity allowed for the development of processes that were tangible and reflected practical business concerns. The research and technology development organization that was used in this study was an organization involved in a diverse range of technology development areas, from manufacturing technologies, such as advanced materials and product development, to biotechnology. The organization employs between 300 and 400 people, and has an annual operating budget of approximately $50 million;
- *review of relevant existing processes and systems* within the organization, specifically:
    - formal project selection processes, and
    - environmental management systems.

In addition, this review was used to determine how projects impact the organization, in order to address the question of "how does a project attract risk and liabilities for an organization";

- *selection of an existing process, or group of processes within the organization* to test develop the proposed system. This would ensure that practical business concerns were dealt with and considered during system development.

  Within the test organization there exists a specific program for investing research funds. This formal investment program, called the Joint Research Venture program (JRV), suited the needs of this study because: (1) it was accessible and known to all project managers within the organization, (2) its decision-making processes had been formalized and documented, and (3) it had a documented history of projects from which case studies could be drawn;
- *selection of project case studies.* Four case studies of projects were chosen – two from within the JRV program, and two external to the JRV program – to test and evaluate the proposed system. It was necessary to choose projects external to the investment program in order to: (1) cover the diverse nature of the development activities within the organization, and (2) ensure the compatibility of the proposed system with other business systems in the organization. A short summary of the case studies used is provided as Appendix 2. The brevity in case

study descriptions reflects the need of the organization to maintain confidentiality;

- *inclusion of the organization's employees* in the study, specifically those involved in the generation and evaluation of project proposals (i.e., staff who were involved in the investment decision process). This was accomplished through the use of workshops and personal interviews.

Two workshops were held, each a half-day in duration. The participants at the workshops included representation from various business investment units from the organization, as dictated by the case studies chosen, and representation from the corporate offices in charge of the investment program. The workshops had the following generic structure:

- formal presentation,
- discussion and dialogue on presented materials,
- case study application.

The first workshop was used to solicit input into the design phase of the proposed system. The case studies were used in the first workshop to identify concerns and issues that highlighted potential constraints for the proposed system. The second workshop was used to validate and obtain feedback on the concept developed for the system. The case studies were used in the second workshop to test the applicability of the processes. At each workshop an informal process, guided by the presentation material, was used to facilitate the discussion, and to obtain input from the project managers responsible for the case studies. Interviews were held with various business unit managers and other project managers from across the organization. These interviews gave staff who were unable to participate in the workshops an opportunity to provide input and feedback to the system under development. The format of the interviews was informal, however, the same material as in the workshops was used to guided and facilitate the discussions; and

- *application of structured systems analysis to model development.* More detail on this component of the study design will be described and discussed in the next section.

4. DEVELOPMENT FRAMEWORK

Standard methodologies used in database and information system design were modified to model the system required to practice environmental due diligence in project selection (Gane and Sarsen, 1979; Elsmari and Navanthe, 1993). Essentially these methodologies provided tools and techniques that allowed a structured systems approach to the analysis. It is a "top-down" approach that enables one to look at the big picture and then focus in on the detail of each piece as and when required (Gane and Sarsen, 1979). It also provides a framework for analyzing and modeling the system requirements. This framework identifies factors that need to be addressed during systems analysis, which are:

- the *components* that make up the system;
- the *elements* that determine the outcome of processes and define the fundamental relationships within the system; and
- the *constraints* on the system.

Each of these factors is discussed in detail in the following sections.

4.1 Components

If one looks in the abstract at any given system, it can generally be described in terms of: (1) the users of the system; (2) the processes that combine to make the system; and (3) the data that are necessary to make the system functional. These are known as the parts or components of the system (Figure 4.1). The following discusses each of these components, first in

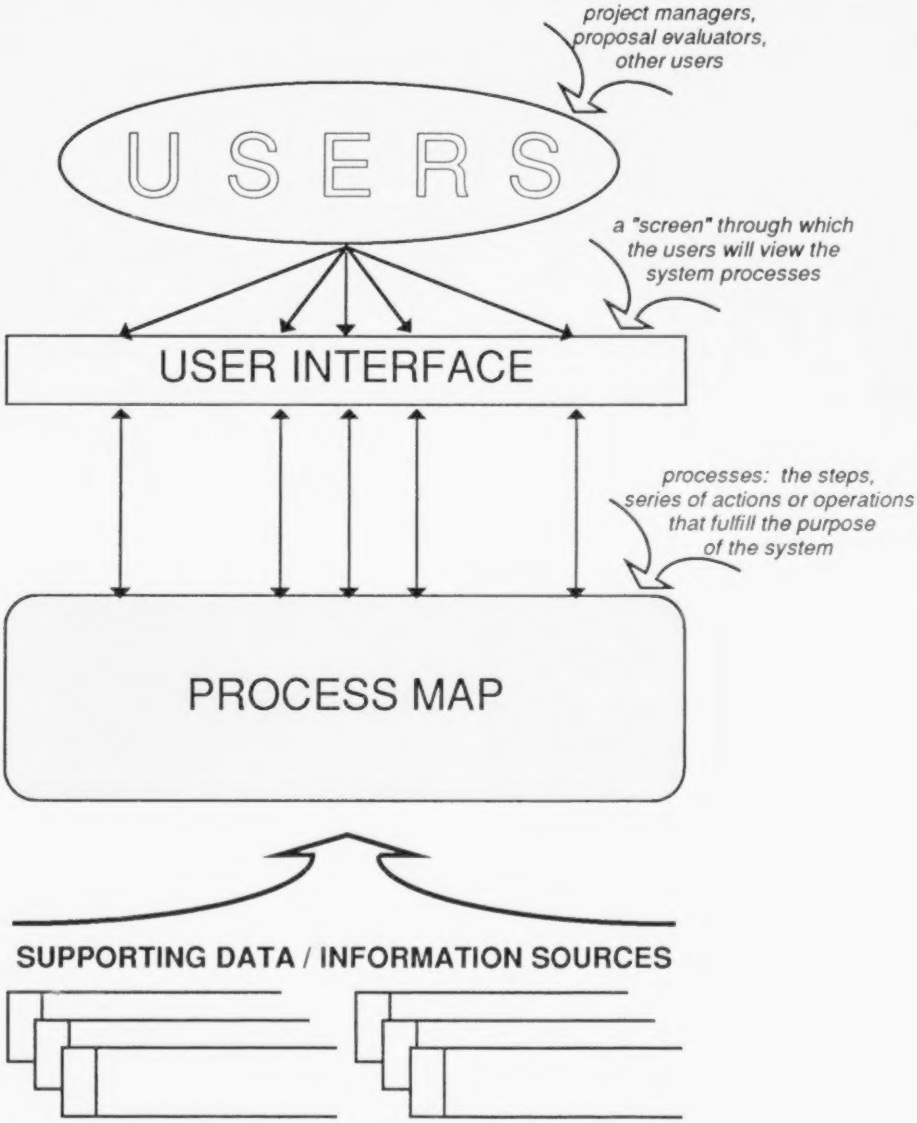

Figure 4.1 A generic representation of the components that make up any system and their relationship to each other. The focus of this thesis is development of the process map.

general terms with respect to system development requirements, and then, where appropriate, in specific terms with respect to the system under development.

4.1.1 Users and User Interface

It is important to understand who the potential users of a given system are in order to:

- understand the intended uses of the system,
- determine the expected knowledge and skill level of the users, and
- develop a credible user-friendly interface.

The user interface is a "screen" through which the users of a system view the processes of the system. This user interface is a very critical aspect of the system and will affect significantly the acceptance of the system by its users.

In the case of the system under development, the users primarily will be the research and technology development organization employees who regularly or casually develop or evaluate project proposals for investment purposes. It is expected that the system will be used during two stages of project development: (1) the formulation of the project proposal, and (2) the evaluation of the project proposal. The knowledge level of individual users will vary with respect to their technical expertise and their awareness of environmental consequences and concerns. It can be expected that all users will have high technical competency in their chosen field, and that the technical fields represented will be very diverse. However, their knowledge level with respect to environmental consequences of their projects will range from little or no knowledge to a high level of knowledge.

4.1.2 Processes and Process Map

Processes are the steps, series of actions or operations, leading to an end, or outcome. In addition to a series of actions, processes also have a purpose, inputs, and outputs. The purpose, inputs, and outputs are sources of constraints for the overall system as well as the process in question. Processes that make up a given system combine to form what is known as a process map. The process map is an extremely useful tool in system analysis and design. As a pictorial model of the system, it allows users to react and provide feedback to the analyst, with respect to the system logic, the assumptions used, and the transformations that occur.

There are several knowns and unknowns in the system under development. The purpose and the overall outcome of the processes are known. The overall purpose of this system is to provide an estimate of the potential sources of environmental risk and liability for the corporation as a result of doing a project. The outcome is the estimate of potential environmental risk and liability for a given project proposal. The unknowns for the system are (1) the series of actions (or steps) used to generate the estimate and (2) the form of the inputs and the output.

4.1.3 Data Requirements

Data requirements address the process/system-specific needs for information. They speak to the sources, forms, and details of the information needed to fulfill the purpose and generate the stated outcome of the processes. Data requirements, therefore, are defined by the processes themselves. Thus, for the system under development, specific data requirements are unknowns that will be defined as the processes themselves are defined.

4.2 Elements

The elements of a system are the factors, stated in the simplest terms, determining the outcome of processes within the system. Another way to look at this is that elements are the information you need to know to understand how the processes within a given system work, both individually and together. The elements of a system are related to the data requirements for the system, by acting as sources for the specific data needs.

The factors, or elements, that will determine the outcome of processes for the system under development are:

- the measures of environmental consequence (environmental performance),
- the environmental management system of the organization, and
- the environmental law system under which the organization operates.

4.2.1 Environmental Performance

Figure 2.1 presented a framework for the systematic evaluation of any given human activity. This framework does not address how one would measure any of these factors. In the case of both economic feasibility and technological feasibility, there exist standard methods and measures by which an activity is evaluated. For example, return on investment methods are commonly applied to test the economic feasibility of an activity, and thermodynamic principles are a commonly applied to test the technological feasibility of an activity. Social acceptability or feasibility does not have as rigorous or objective a measurement method. The social feasibility measure may include factors such as political policies, issue sensitivity, and the legal system. These factors are presented as possibilities, and are not meant to be definitive. Environmental feasibility also does not have a rigorous or formal method of evaluation, however, over the years we have learned to identified some clear "wrong" actions. While the "right" actions remain not so clear, the principles or concepts of "wise use" and "less is better" are good starting points for defining what is primarily a subjective and qualitative measure.

The environmental performance of a given activity is not a straightforward measurement. It may be considered a combination of four factors:

- what is used in the activity (usage),
- what is emitted from the activity (emissions and wastes),
- the interaction of the activity with natural and man-made systems (interactions), and

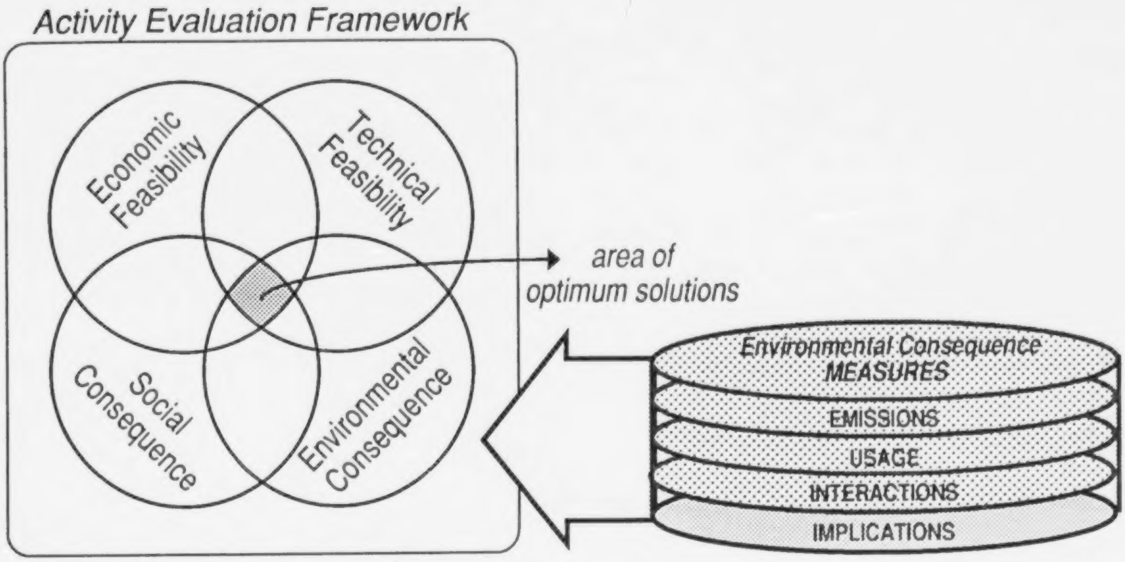
Activity Evaluation Framework
Economic Feasibility
Technical Feasibility
Social Consequence
Environmental Consequence
area of optimum solutions
Environmental Consequence MEASURES
EMISSIONS
USAGE
INTERACTIONS
IMPLICATIONS

Figure 4.2 Factors, when combined, can be used to evaluate the environmental performance of an activity.

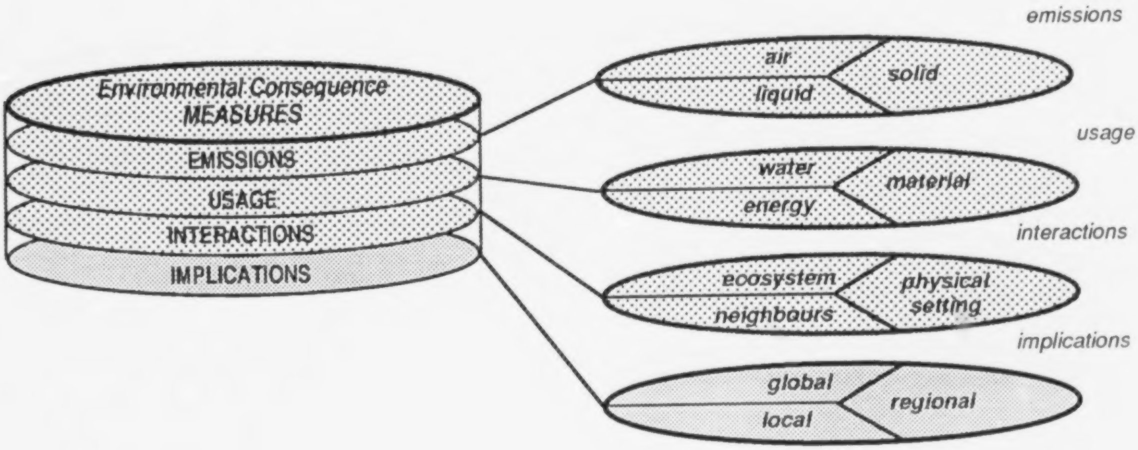

Figure 4.3 Subdivision of the environmental performance factors.

- the implications of the activity on the environment (implications) [Figure 4.2].

Each of these factors can be further subdivided to provide greater detail in the development of measurement objectives (Figure 4.3). This framework provides an efficient basis for assessing the environmental consequence of any activity. It also provides a qualitative guide to potential sources of environmental risk and liability as a result of engaging in an activity. Within research and technology development organizations, activities may be considered to be "projects". Therefore, assessing the environmental performance of projects begins to address the environmental risk and liability the organization faces. In addition, to truly capture the environmental risk and liability for this type of organization, the environmental performance of projects' outcomes (i.e., the product or project deliverable) must also be considered and assessed.

4.2.2 Corporate Environmental Management System

The relationship between projects and an organization is determined by the corporate management structures that exist within the organization. The impact on the corporation of any given project depends on the underlying structure of the organization.

The organizational structure of the environmental management system in the research and technology development organization used in this study is modeled in Figure 4.4. It addresses each of the major stakeholders of the organization through an understanding of the relationship between each

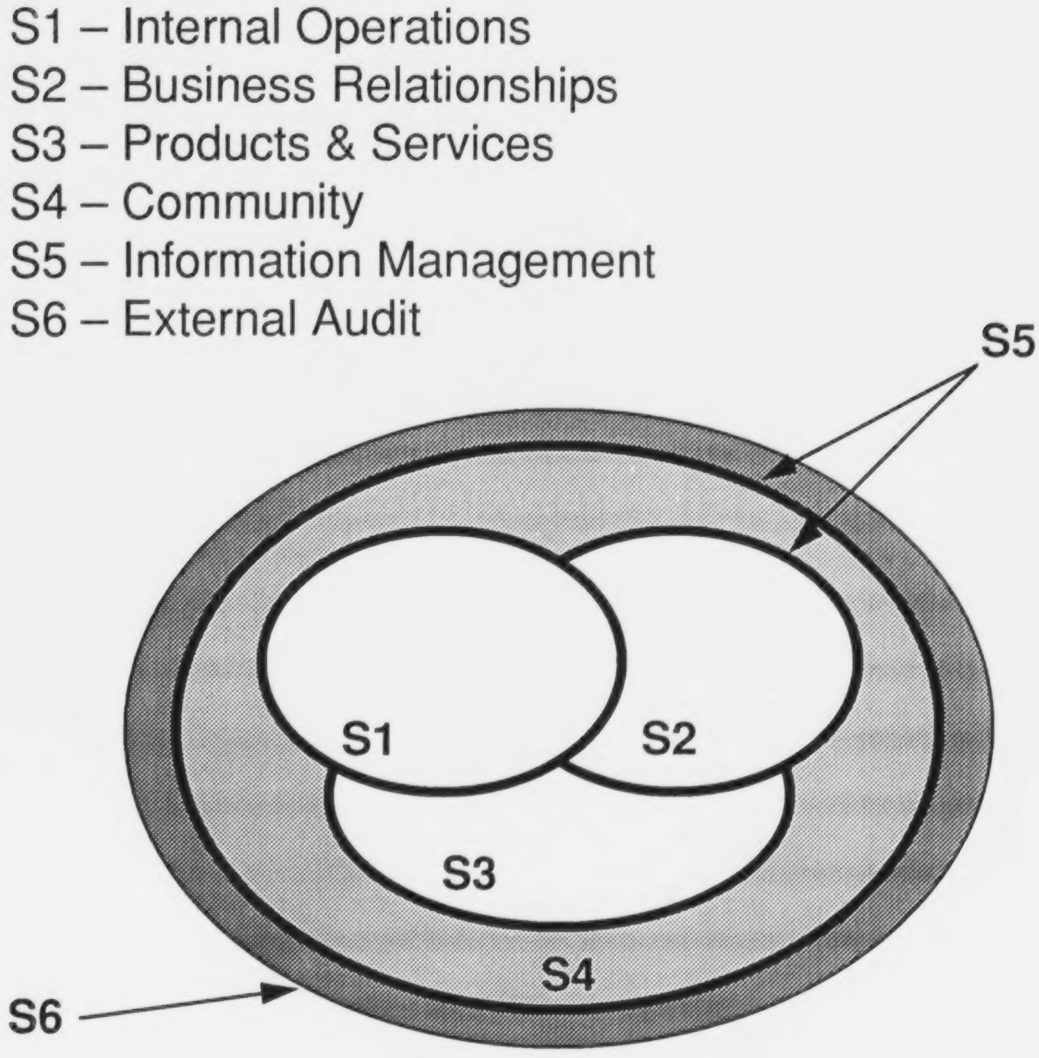

Figure 4.4 A model of the environmental management system in use within the research and technology development organization studied. Descriptions of the various elements in the EMS are provided in Table 4.1

stakeholder and the organization itself. As shown in Figure 4.4, there are six interrelated systems that make up the organization's EMS. A description of each system is provided as Table 4.1. The system that is responsible for initiating projects within the organization is System 3 – Products & Services. As indicated in Table 4.1, this system is responsible for:

> "ensuring due diligence in selection of projects and development of products that operate in an environmentally responsible manner throughout their life-cycle".

The proposed system for identification of environmental risk and liability associated with projects directly addresses the objectives of System 3. It is a tool that will allow the System 3 objectives to be fulfilled.

Other systems within the research and technology development organization are also impacted by projects, as is demonstrated in Figure 4.4. The sphere that represents System 3 – Products & Services overlaps with two other spheres that represent other systems in the organization's EMS. Specifically, projects also impact System 1 – Operations (i.e., a project conducts activities within the corporate operational infrastructure), and System 2 – Business Relationships (i.e., a project helps define the "who" the corporation has business relationships with). Overall, in developing a workable system to address the organization's environmental risk and liability, these overlaps will need to be considered and addressed. However, the focus of this work will be to address those issues that are specific to System 3 – Products & Services.

Table 4.1 Descriptions of the systems within the environmental management system of the research and technology development organization studied (ARC, 1994)

System	Title	Description
1	Internal Operations	• Ensuring that our operations comply with the organization's environmental strategic intent and the organization's legal and regulatory obligations.
2	Business Relationships	• Ensuring due diligence in relationships with customers, suppliers, and partners.
3	Products & Services	• Ensuring due diligence in selection of projects and development of products that operate in an environmentally responsible manner throughout their life-cycle.
4	Community	• Ensuring that the organization is and is seen to be an environmentally responsible corporate citizen.
5	Environment/Safety Management System	• Ensuring ready access to information on the status of the entire Environment/Safety System; and • The information support structure to enable Systems 1 through 4 to operate in an efficient and effective manner.
6	External Audit	• Ensuring outside auditors validate our results

4.2.3 Environmental Law System

The environmental law system under which a given research and technology development organization falls defines two things. First, the environmental law system defines the specific sources of environmental liability that may apply to the organization. These sources are found in the legislation, regulations, and by-laws that make up the environmental law system in the jurisdiction in question. Second, the environmental law system helps to define the guiding principles around environmental matters. These guiding principles, in essence, determine the "how" and "what" by which a corporation's environmental management will be judged. Guiding principles are found in court interpretations of statutes, the statutes themselves, treaties, and the Constitution. Of course the environmental law system is not the only source of environmental guiding principles, however, this system does reflect the same principles that are postulated by society, industry organizations, and professional organizations.

The research and technology development organization that is serving as the test bed for developing this environmental risk management system operates under the legal jurisdiction of the Province of Alberta. The legal jurisdiction determines the relevant legislative and regulatory framework. This in turn, defines specific and formal environmental risks and liabilities for the organization. As this statement implies, what formally constitutes an environmental risk and liability will change depending on the demands of the legal jurisdiction.

In Alberta there are two primary pieces of legislation (or key statutes) that directly address the environment. These are the federal and provincial environmental protection Acts, known as the Canadian Environmental Protection Act (CEPA) and the Alberta Environmental Protection and Enhancement Act (AEPEA), respectively. The legislatively-defined purposes of the Acts are given in Figures 4.5 and 4.6, respectively. In essence, CEPA's focus is on substances, particularly the control and release of toxic substances; whereas AEPEA's focus is on activities and the environmental impact or interaction around specific activities. Each of these Acts has given rise to a full suite of environmental regulations and other legal instruments, which are summarized in Tables 4.2 and 4.3, respectively. However, as indicated previously, not all environmentally-related regulations are as a result of CEPA and AEPEA. Some environmentally-related regulations are within the purview of other legislative Acts. Other federal and provincial Acts and regulations that have relevant environmental components, and meet the environmental law definition of Franson (1992) are summarized in Tables 4.4 and 4.5. The most relevant Acts and regulations from the federal jurisdiction are the Fisheries Act, the Canadian Environmental Assessment Act (added to the statutes January, 1995), and the Transportation of Dangerous Goods Act (Moen, 1995). At the provincial level the most relevant of the various Acts and regulations is the Transportation of Dangerous Goods Control Act (Moen, 1995).

Whereas the presence of toxic substances in the environment is a matter of national concern;

Whereas toxic substances, once introduced into the environment, cannot always be contained within geographic boundaries;

Whereas the Government of Canada in demonstrating national leadership should establish national environmental quality objectives, guidelines and codes of practice;

Whereas it is necessary to control the dispersal of nutrients in Canadian waters;

Whereas some of the laws under which federal lands, works and undertakings are administered or regulated do not make provision for environmental protection in respect of federal lands, works and undertakings;

And Whereas Canada must be able to fulfill its international obligations in respect of the environment;

Now Therefore, Her Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:

1. This Act may be cited as the *Canadian Environmental Protection Act.*

Figure 4.5 The purpose of the Canadian Environmental Protection Act, as signified by the preamble to the Act.

2 The purpose of this Act is to support and promote the protection, enhancement and wise use of the environment while recognizing the following:

(a) the protection of the environment is essential to the integrity of ecosystems and human health and to the well-being of society;

(b) the need for Alberta's economic growth and prosperity in an environmentally responsible manner and the need to integrate environmental protection and economic decisions in the earliest stages of planning;

(c) the principle of sustainable development, which ensures that the use of resources and the environment today does not impair prospects for their use by future generations;

(d) the importance of preventing and mitigating the environmental impact of development and of government policies, programs and decisions;

(e) the need for Government leadership in areas of environmental research, technology and protection standards;

(f) the shared responsibility of all Alberta citizens for ensuring the protection, enhancement and wise use of the environment through individual actions;

(g) the opportunities made available through this Act for citizens to provide advice on decisions affecting the environment

(h) the responsibility to work co-operatively with other provinces and the Government of Canada to prevent and minimize transboundary environmental impacts;

(i) the responsibility of polluters to pay for the costs of their actions;

(j) the important role of comprehensive and responsive action in administering this Act

Figure 4.6 Purpose of Alberta's Environmental Protection and Enhancement Act.

Table 4.2 CEPA Regulations

Name	Reference
Asbestos Mines and Mills Release Regulations	SOR/90-341
Chlor-Alkali Mercury Release Regulations	SOR/90-130
Chlorobiphenyls Regulations	SOR/91-152
Chlorofluorocarbon Regulations, 1989	SOR/90-127
Mirex Regulations, 1989	SOR/90-126
Polybrominated Biphenyls Regulations, 1989	SOR/90-129
Polychlorinated Terphenyls Regulations, 1989	SOR/90-128
Secondary Lead Smelter Release Regulations	SOR/91-155
Vinyl Chloride Release Regulations, 1992	SOR/92-631
Storage of PCB Material Regulations	SOR/92-507
Ozone-depleting Substances Regulations	SOR/94-408
Contaminated Fuel Regulations	SOR/91-485
Phosphorus Concentration Regulations	SOR/89-501
Fuels Information Regulations, No. 1 and amendments	SOR/77-597
Gasoline Regulations	SOR/90-247
PCB Waste Export Regulations	SOR/90-453
Ocean Dumping Regulations and amendment	SOR/89-500
Federal Mobile PCB Treatment and Destruction Regulations	SOR/90-5
Notice wrt Methyl Bromide (Bromomethane), Whether alone or in a mixture	
New Substances Notification Regulations	SOR/94-260
Glycol Guidelines	
Notice to anyone engaged in the production, import or export of Hydrobromofluorocarbons and/or Hydrochlorofluorocarbons, whether existing alone or in a mixture	
Masked Name Regulations	SOR/94-261
Pulp and Paper Mill Defoamer and Wood Chip Regulations	SOR/92-268
Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations	SOR/92-267
Canadian Environmental Protection Act (CEPA) Omnibus Amendment Order, 1992	SOR/92-587
Notice with respect to Inorganic Fluorides	
Export and Import of Hazardous Wastes Regulations	SOR/92-637
Toxic Substances Export Notification Regulations	SOR/92-634

Table 4.3 Alberta Environmental Protection and Enhancement Act Regulations

Name	Reference
Activities Designation Regulation	AR 110/93
Air Emission Regulation	AR 124/93
Approvals Procedure Regulation	AR 113/93
Beverage Container Recycling Regulation	AR 128/93
Conservation And Reclamation Regulation	AR 115/93
Disclosure Of Information Regulation	AR 116/93
Environmental Appeal Board Regulation	AR 114/93
Environmental Assessment (Mandatory And Exempted Activities) Regulation	AR 111/93
Environmental Assessment Regulation	AR 112/93
Environmental Protection And Enhancement (Miscellaneous) Regulation	AR 118/93
Industrial Plants Regulation	AR 121/93
New Tire Advance Disposal Surcharge By-Law	AR 258/92
Ozone-Depleting Substances Regulation	AR 125/93
Pesticide Sales, Handling, Use And Application Regulation	AR 126/93
Pesticide (Ministerial) Regulation	AR 127/93
Potable Water Regulation	AR 122/93
Release Reporting Regulation	AR 117/93
Tire Recycling And Management Regulation	AR 249/92
Tire Recycling Management Board By-Law	AR 257/92
Waste Control Regulation	AR 129/93
Wastewater And Storm Drainage (Ministerial) Regulation	AR 120/93
WasteWater And Storm Drainage Regulation	AR 119/93
Water Well Regulation	AR 123/93

Table 4.4 Other federal legislation, regulations, and instruments that have environmental components, as of June, 1994 (Canadian Environmental Law, 1992).

Act	Regulation
Arctic Waters Pollution Act (R.S.C. 1985, c. A-12)	• Arctic Waters Pollution Prevention (C.R.C., c. 354) • Governor in Council Authority Delegation Order (C.R.C., c. 355) • List of Regulations under the Act
Atomic Energy Control Act (R.S.C. 1985, c. A-16)	
Canada Petroleum Resources Act (R.S.C. 1985, c. 36 (2nd Supp.))	
Canada Shipping Act (R.S.C. 1985, c. S-9)	• Air Pollution Regulations (C.R.C., c. 1404) • Fisherman's Notice of Claims for Loss of Income (Form) (C.R.C., c. 1423) • Garbage Pollution Prevention Regulations (C.R.C., c. 1424) • Great Lakes Sewage Pollution Prevention Regulations (C.R.C., c. 1429) • Oil Pollution Prevention Regulations (SOR/93-3) • Pollutant Discharge Reporting Regulations (SOR/92-211) • Pollutant Substances Regulations (C.R.C., c. 1458) • Ship-source Oil Pollution Fund Regulations (SOR/90-82)
Canada Water Act (R.S.C. 1985, c. C-11)	
Canada Wildlife Act (R.S.C. 1985, c. W-9)	
Criminal Code (R.S.C. 1985, c. C-46)	
Department of Forestry Act (S.C. 1989, c. 27, ss. 1-13)	
Department of the Environment Act (R.S.C. 1985, c. E-10)	• Environmental Assessment and Review Process Guidelines Order (SOR/84-467)

continued ...

Table 4.4 Continued.

Act	Regulation
Emergencies Act (R.S.C. 1985, c. 22 (4th Supp.))	
Energy Efficiency Act (S.C. 1992, c. 36)	
Energy Supplies Emergency Act (R.S.C. 1985, c. E-9)	
Environment Contaminants Act (R.S.C. 1985, c. E-12, s. 9)	
Fisheries Act (R.S.C. 1985, c. F-14)	• Chlor-Alkali Mercury Liquid Effluent Regulations (C.R.C., c. 811) • Fish Toxicant Regulations (SOR/88-258) • Fishery (General) Regulations (SOR/93-53) • Meat and Poultry Products Plant Liquid Effluent Regulations (C.R.C., c. 818) • Metal Mining Liquid Effluent Regulations (C.R.C., c. 819) • Penalties & Forfeitures Proceeds Regulations (C.R.C., c. 827) [Revoked SOR/93-53] • Petroleum Refinery Liquid Effluent Regulations (C.R.C., c. 828) • Potato Processing Plant Liquid Effluent Regulations (C.R.C., c. 829) • Pulp and Paper Effluent Regulations (SOR/92-269)
Forestry Act (R.S.C. 1985, c. F-30)	
Game Export Act (R.S.C. 1985, c. G-1)	
Hazardous Materials Information Review Act (R.S.C. 1985, c. 24 (3rd Supp.), Part III)	• Hazardous Materials Information Review Regulations (SOR/88-456) • Hazardous Materials Information Review Act Appeal Board Procedures Regulations (SOR/91-86)

continued ...

Table 4.4 Continued.

Act	Regulation
International River Improvement Act (R.S.C. 1985, c. I-20)	
Migratory Birds Convention Act (R.S.C. 1985, c. M-7)	
National Energy Board Act (R.S.C. 1985, c. N-7)	• National Energy Board Cost Recovery Regulations (SOR/91-7) • National Energy Board Part VI Regulations (C.R.C., c. 1056) • National Energy Board Rules of Practice and Procedure (C.R.C., c. 1057) • Oil Product Designation Regulations (SOR/88-216) • Onshore Pipeline Regulations (SOR/89-303)
Navigable Waters Act (R.S.C. 1985, c. N-22)	
Northwest Territories Water Act (S.C. 1992, c. 39)	
Northern Inland Waters Act (R.S.C. 1985, c. N-25) [repealed by S.C. 1992, c. 40, s. 52]	• Northwest Territories Waters Regulations (SOR/93-303) • Northern Inland Waters Regulations (C.R.C., c. 1234) [repealed by SOR/93-303]
Nuclear Liability Act (R.S.C. 1985, c. N-28)	
Canadian Oil and Gas Operations Act	• Canada Oil and Gas Production and Conservation Regulations (SOR/90-791) • Oil and Gas Spills and Debris Liability Regulations (SOR/87-331)
Pest Control Products Act (R.S.C. 1985, c. P-9)	• Pest Control Products Regulations (C.R.C., c. 1253)

continued ...

Table 4.4 Concluded.

Act	Regulation
Territorial Lands Act (R.S.C. 1985, c. T-7)	• Territorial Land Use Regulations (C.R.C., c. 1524) • List of Regulations under the Act
Transportation of Dangerous Goods Act, 1992 (S.C. 1992, c. 34)	• Transportation of Dangerous Goods General Policy Advisory Council Order (SOR/90-153) • Transportation of Dangerous Goods Regulations (SOR/85-77)
Weather Modification Information Act (R .S.C. 1985, c. W-5)	• Weather Modification Information Regulations (C.R.C., c. 1604)

Table 4.5 Other provincial (Alberta) legislation, regulations, and instruments that have environmental components, as of June, 1994 (Canadian Environmental Law, 1992).

Act	Regulation
Alberta Environmental Research Trust Act (R.S.A. 1980, c. A-20)	
Clean Air Act	• Application for Permit or License under The Clean Air Act (Dept. of the Environment)
Clean Water Act	• Application for Permit or License under The Clean Water Act (Dept. of the Environment) • Waste Water Effluent Guidelines for Alberta Petroleum Refineries (Alta Reg. 35/73)
Coal Conservation Act (R.S.A. 1980, c. C-14)	• A Coal Development Policy for Alberta
Department of the Environment Act (R.S.A. 1980, c. D-19)	• Environment Grant Regulations (Alta Reg. 51/76) • List of Restricted Development Area Regulations
Energy Resources Conservation Act (R.S.A. 1980, c. E-11)	
Environment Council Act (R.S.A. 1980, c. E-13)	
Hydro and Electric Energy Act (R.S.A. 1980, c. H-13)	
Land Surface Conservation and Reclamation Act	• Alberta Environmental Impact Assessment Guidelines • Energy Resources Conservation Board Informational Letter IL-80-19
Natural Resources Conservation Board Act (S.A. 1990, c. N-5.5)	
Oil and Gas Conservation Act (R.S.A. 1980, c. O-5)	
Oil Sands Conservation Act (S.A. 1983, c. O-5.5)	• Oil Sands Conservation Regulation (Alta. Reg. 76/88)
Pipeline Act (R.S.A. 1980, c. P-8)	

continued ...

Table 4.5 Concluded.

Act	Regulation
Public Health Act (S.A. 1984, c. P27.1)	• List of Regulations under the Act • Nuisances and General Sanitation Regulations (Alta. Reg. 242/85) • Waste Management Regulation (Alta. Reg. 250/85)
Public Lands Act (R.S.A. 1980, c. P-30)	
Special Waste Management Corporation Act (S.A. 1982, c. S-21-5)	
Transportation of Dangerous Goods Control Act (S.A. 1982, c. T-6.5)	• Transportation of Dangerous Goods Control Regulation (Alta. Reg. 383/85)
Water, Gas and Electric Companies Act (R.S.A. 1980, c. W-4)	
Water Resources Commission Act (S.A. 1983, c. W-5.1)	
Wilderness Areas, Ecological Reserves and Natural Areas Act (R.S.A. 1980, c. W-8)	

Again, this legislative and regulatory framework determines the specifics with respect to what constitutes an environmental risk and liability. For example, if a material or substance appears in any of the aforementioned regulations, and a project uses or generates that material or substance, then that may be an environmental risk or liability for the project, and therefore for the organization. More detail on the application of the environmental law system as the source of environmental risk and liability for an organization will be discussed in future sections.

4.3 Constraints

Constraints in any given system are used to (1) help define the system boundaries; and (2) help determine the functional requirements of the system. Generally speaking, they are best defined by the users of the system. In the case of a system to practice environmental due diligence in project selection, a number of constraints were identified, primarily through a workshop with a cross-section of staff in the research and technology development organization who were responsible for the development and approval of project proposals. The case studies were used to identify concerns and issues that highlighted the potential constraints. This was done through an informal discussion process around each case study. This group identified the following as constraints on the system:

- be explicit;
- be flexible;

- be a component of the project reporting/milestone process;
- be iterative, i.e., when a project's scope changes the project will need to be re-assessed;
- provide guidance to researcher in assessing environmental consequences by increasing the researcher's awareness of environmental issues with respect to his/her research;
- provide pointers to and/or further assistance when required;
- recognize and address the diverse nature of activities done within the organization; and
- avoid being bureaucratic, onerous, or cumbersome.

Most of these constraints pertain primarily to how the user views the system (i.e., the user interface), and as such these constraints address functional requirements of the system. Some constraints were also helpful in defining the boundaries of the system. The system boundaries were also defined by the organization's EMS (i.e., System 3 – Products & Services)

The constraints identified by the workshop participants reflect and provide insight into concerns within a "real" organization. Systems and processes, such as the one proposed here, need to accommodate two conflicting needs. The first is the need for the organization to make fully informed decisions with respect to managing its risks. The second is the need for staff to conduct projects in a cost-effective and efficient manner. Adding information and process requirements to the project initiation stage, tends to be viewed as an added cost in delivering a project. Hence the identification of constraints that the process needs to explicit, flexible, and avoid being bureaucratic, onerous or cumbersome. Both the corporate need and the project staff need must be understood and balanced in any system solution.

Also reflected in the constraints identified by the workshop participants were two other concerns that have been previously identified. The first concern was that the knowledge level of individual users, with respect to both technical areas of expertise and environmental consequences and concerns will be variable, as discussed under "Users and User Interface". The second concern was the diverse nature of the work done within the research and technology development organization. Participants at the workshop recognized that both of these issues would need to be address in developing a suitable system solution.

Inherent in the response by workshop participants, but not specifically identified as such, is the need for the system to identify environmental risks that are considered "reasonable" and "foreseeable". The reasonableness and foreseeability criteria are key components in the concept of due diligence. As the proposed system is intended to assist a research and technology development organization in practicing environmental due diligence with respect to project selection, reasonableness and foreseeability are obviously key constraints for the system.

5. A PROCESS FOR ENVIRONMENTAL DUE DILIGENCE IN PROJECT SELECTION

5.1 Purpose

> "...[E]ven in this bleakest of financial times, the environment must not be a sacrificial lamb on the altar of corporate survival."
>
> Judge Ormston in the
> sentencing decision in R. v. Bata

Corporations need to make project selection decisions that are fully informed with respect to business and technology risks. To not do so can significantly impact a corporation's "bottom line". Environmental risks, in essence, may be considered one type of business and technology risk. Along with traditional technological and business due diligence (the latter focuses on financial aspects of a investment decision, such as return on investment risks), environmental due diligence needs to be included and integrated into the suite of tools used to provide information prior to investment decisions. The purpose of an environmental due diligence process within a research and technology development organization has three aspects:

1. to ensure that due diligence with respect to environmental concerns has been exercised,
2. to document that the process has occurred, and
3. to increase awareness among staff of the environmental consequences of research and technology development activities.

This purpose can be accomplished by identifying the potential sources of environmental risk and liability for the organization that can arise from investing in a given project.

5.2 Process Description

The proposed system for environmental due diligence in project selection has four primary processes. These processes arise from how a project impacts the organization. In the organization studied, the impact of a project arises from:

- doing the project,
- the relationship with the client/partner/business associate,
- the outcome of the project (the project deliverable), and
- the project deliverable in use.

For a given project, each of these impact stages will:

- have different environmental risks and liabilities associated with it (i.e., the risk issues will be different for each impact stage),
- require different risk identification strategies,
- have different data requirements, and
- require different risk management strategies.

A map, or model, of the proposed processes is provided as Figure 5.1. The four primary processes essentially mirror the four impact stages and address the risk identification requirements at each of these stages. The diagram in Figure 5.1 is termed a" top-level" map of the system. A top-level diagram is a simplified representation of the logic of the system. Each of the process boxes in the top-level diagram summarizes considerable detail. To show more detail, the process box is exploded into a lower-level, more detailed diagram. To show which of the processes in the top-level diagram may be exploded into further

Process for Estimating Environmental Risk & Liabilities (ER&L) Associated with Projects

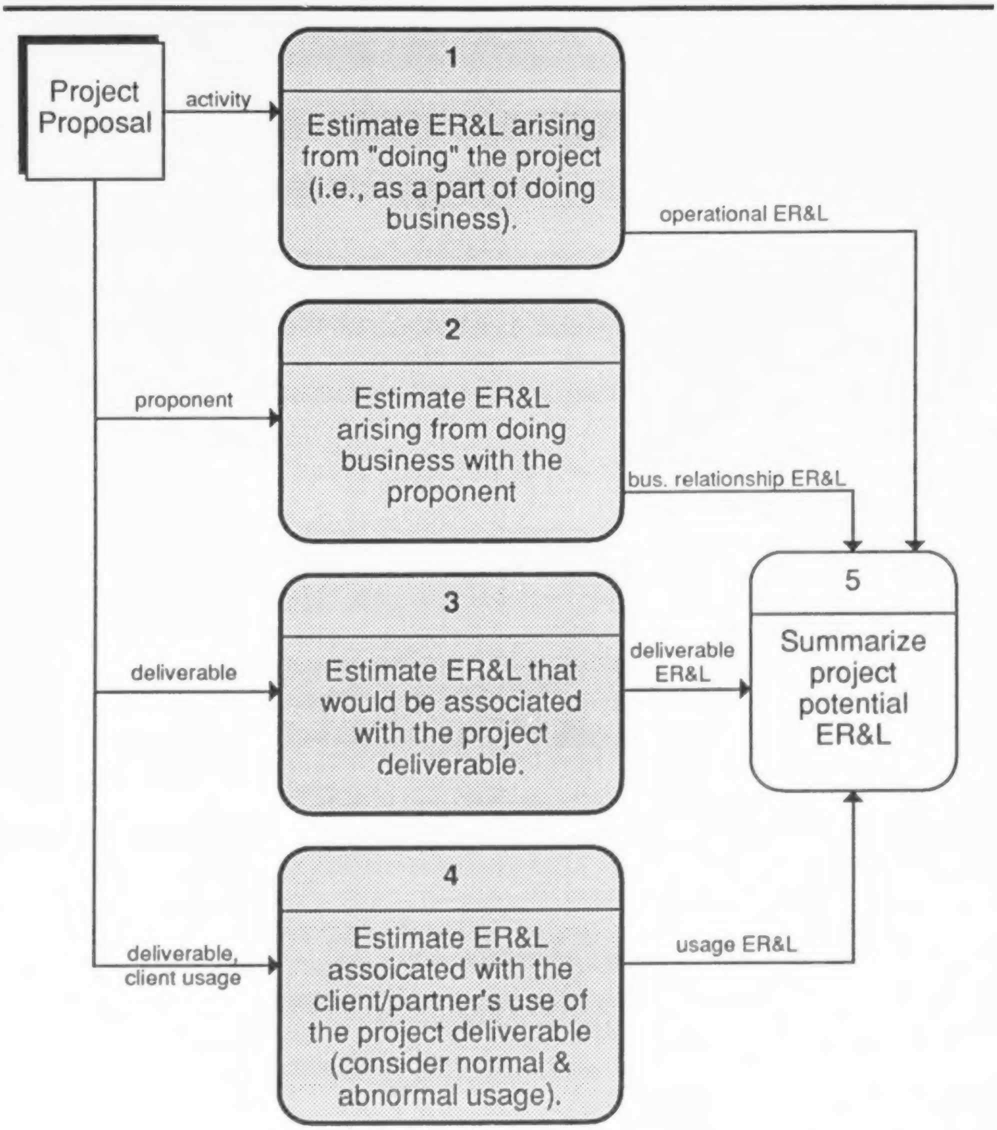
Project Proposal
activity
1
Estimate ER&L arising from "doing" the project (i.e., as a part of doing business).
operational ER&L
proponent
2
Estimate ER&L arising from doing business with the proponent
bus. relationship ER&L
5
Summarize project potential ER&L
deliverable
3
Estimate ER&L that would be associated with the project deliverable.
deliverable ER&L
deliverable, client usage
4
Estimate ER&L assoicated with the client/partner's use of the project deliverable (consider normal & abnormal usage).
usage ER&L

Figure 5.1 Top level process map for the process: Estimating Environmental Risk & Liabilities Associated with Projects.

detail, the process number is shown in bold. Each of the primary processes require development of exploded process maps.

In the organization used as the model for research and technology development organizations, projects and project selection were identified as the organization's EMS System 3 – Products & Services (Figure 4.4 and Table 4.1). The sphere of concerns that represent System 3 overlap with other EMS systems. As discussed previously, an overall system to address the organization's environmental risk and liability needs to consider and address the overlaps with other systems in its EMS. This has been considered and addressed by the proposed processes as shown in the process map (Figure 5.1). The first two (2) processes in the process map (Processes 1 and 2), are processes that have significant overlap with other systems in the research and technology development organization's EMS (System 1 – Operations and System 2 – Business Relationships, respectively). The next two (2) processes (Processes 3 and 4) deal with issues that are solely in the realm of the organization's System 3 – Product & Services. In order to develop the exploded process maps (as is indicated by the bold numbering [Figure 5.1]) expertise from the appropriate EMS system will be required. Since the focus of this work was on issues that were specific to System 3 – Products & Services, exploded process maps have only been developed for Processes 3 and 4. It is recognized, however, that to be truly operational, exploded process maps for all processes will need to be developed. The following sections discuss each of the top level processes in more detail.

5.2.1 Process 1

Process 1 is the estimation of the environmental risk and liability associated with the "doing" of the project. Its focus is on the internal activities that lead to the project deliverable, and thus addresses the direct impact the project has on the operational infrastructure of the organization. As such, this process overlaps with concerns in the realm of the organization's EMS System 1 – Operations, and requires System 1 expertise to more fully develop the process. System 1 expertise required to develop this process would include representation from: occupational health, safety and hygiene; facilities; stores (shipping & receiving); and other infrastructure-related groups within the organization.

Two of the key questions that will need to be addressed as part of this process are:

- what are the proposed activities in the project, and
- what are the operational facility requirements for the project.

The answers to each of these questions can be used to narrow the relevant potential sources of environmental risk and liability arising from System 1 – Operations for the organization based on a given project.

5.2.2 Process 2

Process 2 is the estimation of the environmental risk and liability associated with the business relationship with the client. As such, this process overlaps with concerns in the realm of the organization's EMS System 2 –

Business Relationships, and requires System 2 expertise to more fully develop the process. Expertise that will be required to develop this process will include various sectors of the organization, such as: legal, marketing, program managers, corporate relations, as well as other members of senior management. This process needs to address issues around the acquisition of environmental risk and liability through the business relationship. For example, questions such as how does the client/partner/customer view environmental management, or have [they] had any environmental violations, will need to be addressed, in conjunction with questions around what type of business relationship does the organization have with the client. Different types of business relationships inevitably have different levels of environmental risk.

5.2.3 Process 3

Process 3 is the estimation of the environmental risk and liability associated with the project deliverable itself. This process has as its focus part of the System 3 (Products & Services) concerns for a research and technology development organization. The exploded process is provided as Figure 5.2. Process 3 explodes into four subprocesses, which are:

- *identification of the project deliverable(s)*; i.e., what is the anticipated outcome of the project, what is the client/customer/partner expecting;
- *classification of the project deliverable(s).* This step is used to narrow the sources of environmental risk and liability from a project deliverable early in the process. The classification scheme of deliverables at this stage is given as Figure 5.3;

3.
Estimate ER&L that would be associated with the project deliverable.

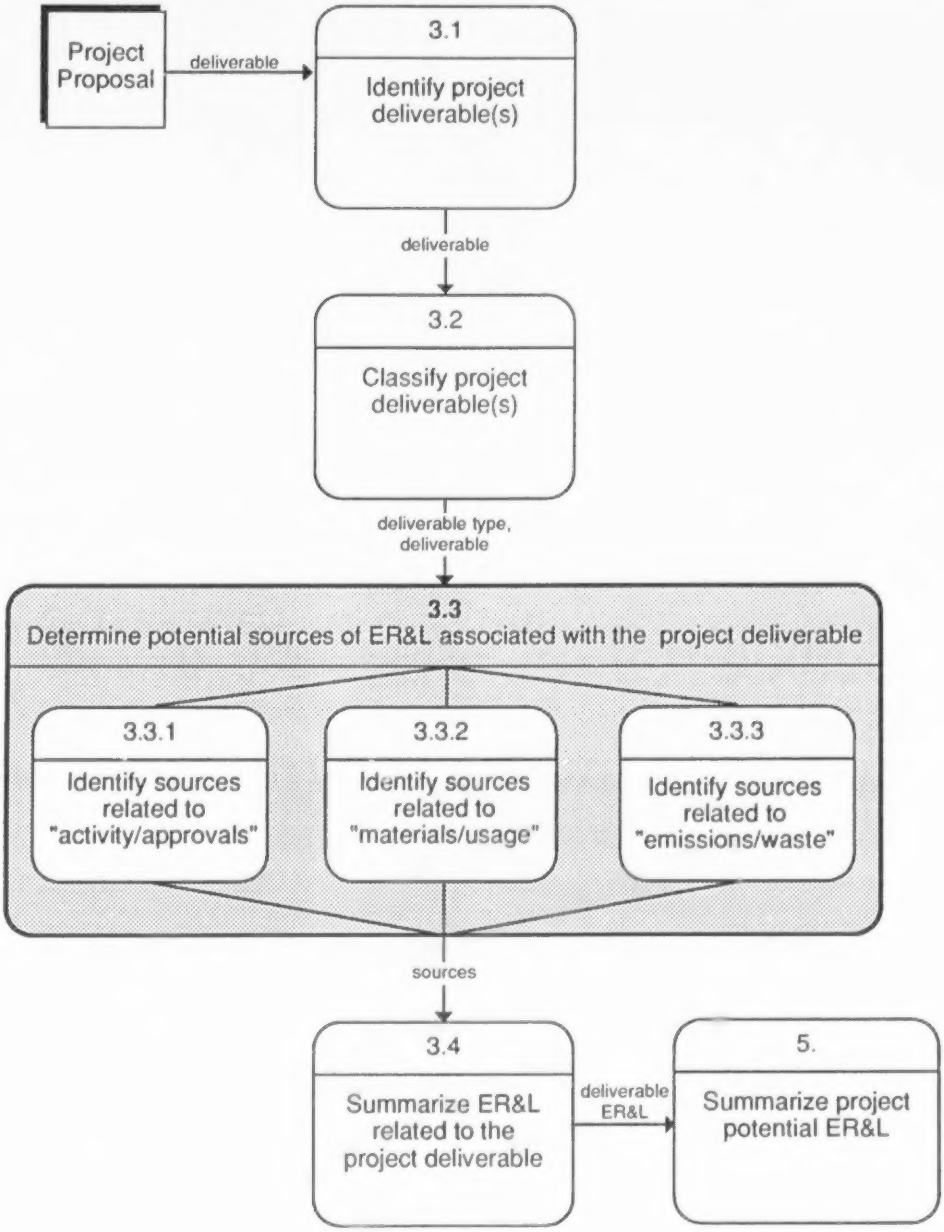
Project Proposal
deliverable
3.1
Identify project deliverable(s)
deliverable
3.2
Classify project deliverable(s)
deliverable type, deliverable
3.3
Determine potential sources of ER&L associated with the project deliverable
3.3.1
Identify sources related to "activity/approvals"
3.3.2
Identify sources related to "materials/usage"
3.3.3
Identify sources related to "emissions/waste"
sources
3.4
Summarize ER&L related to the project deliverable
deliverable ER&L
5.
Summarize project potential ER&L

Figure 5.2 Exploded process map for the process: Estimating Environmental Risk & Liabilities that would be associated with the project deliverable.

Deliverable Types

1. THINGS	2. REPORTS
	• Data • Description • Evaluation • Recommendation

Figure 5.3 Categories of deliverable types for Process 3

- *identification of the potential sources of environmental risk and liability associated with the project deliverable.* This step identifies the sources of risk and liability as a function of different environmental evaluation measures. This concept will be discussed in more detail below; and finally,
- *summation of the environmental risk and liability sources for the organization from the project deliverable.*

As indicated in a previous section, the environmental performance of an activity can be measured through a combination of what is used in the activity, what is emitted from the activity, the interaction of the activity with natural and man-made systems, and the implications of the previous three on local, regional, and global environmental concerns. This same framework can be used to structure the sources and guide the identification of environmental risk and liability for a given project deliverable (Figure 5.4).

Sources of environmental risk and liability may be categorized as:

- sources relating to regulated activities and approvals,
- sources relating to materials and usage, and
- sources related to emissions and waste.

The advantages of this framework for identifying environmental risk and liability are two-fold. First, it again allows one to very quickly narrow the potential sources of environmental risk and liability to what is relevant for the project deliverable. Second, it identifies where or what aspect of the project deliverable the environmental risk and liability arises from.

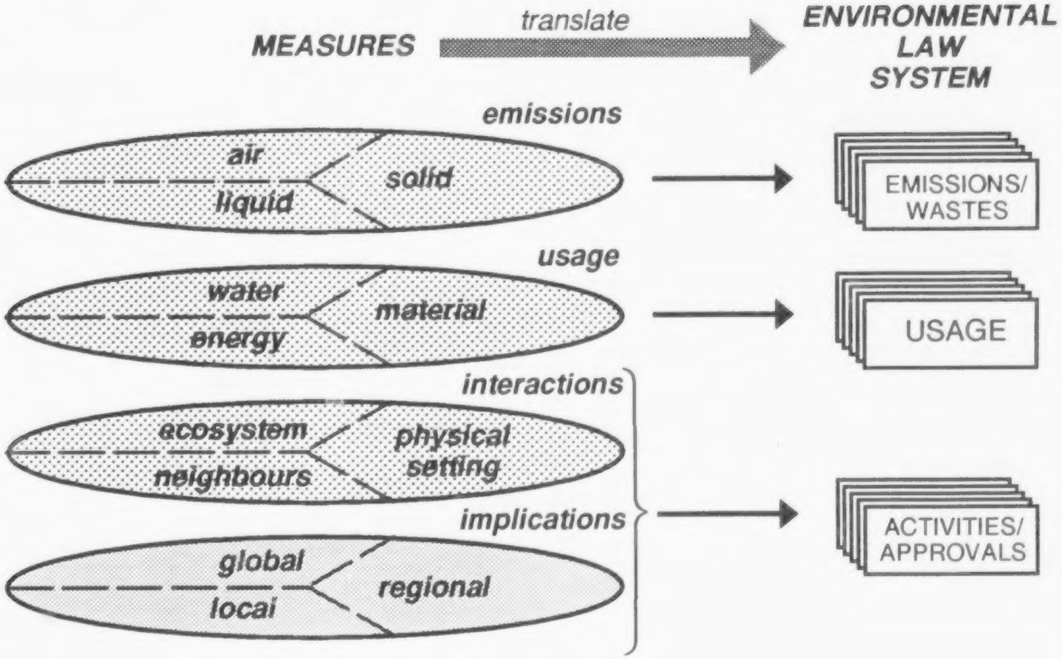

Figure 5.4 Translation of measures of environmental performance into sources of environmental liability as determined by the environmental law system.

5.2.4 Process 4

Process 4 is the estimation of the environmental risk and liability associated with using the project deliverable. This process addresses the remaining part of the System 3 (Products & Services) concerns for a research and technology development organization. The exploded process map is provided as Figure 5.5. Process 4 explodes into 4 subprocesses, some of which are analogous to the subprocesses discussed under Process 3:

- identification of type of project deliverable;
- identify usage scenarios for the deliverable;
- identify the potential sources of environmental risk and liability relating to the uses of the deliverable; and
- summation of the environmental risk and liability sources for the organization from the deliverable in use.

The first of the subprocesses, identification of the type of project deliverable, is similar to the first two steps in Process 3. The difference is in first, the classification scheme, and second, in the use to which this information is put. The classification scheme of project deliverables for the purpose of this process is provided as Figure 5.6. This classification assists and guides the potential user of the system with the next step in the process: identifying the usage scenarios for a project deliverable.

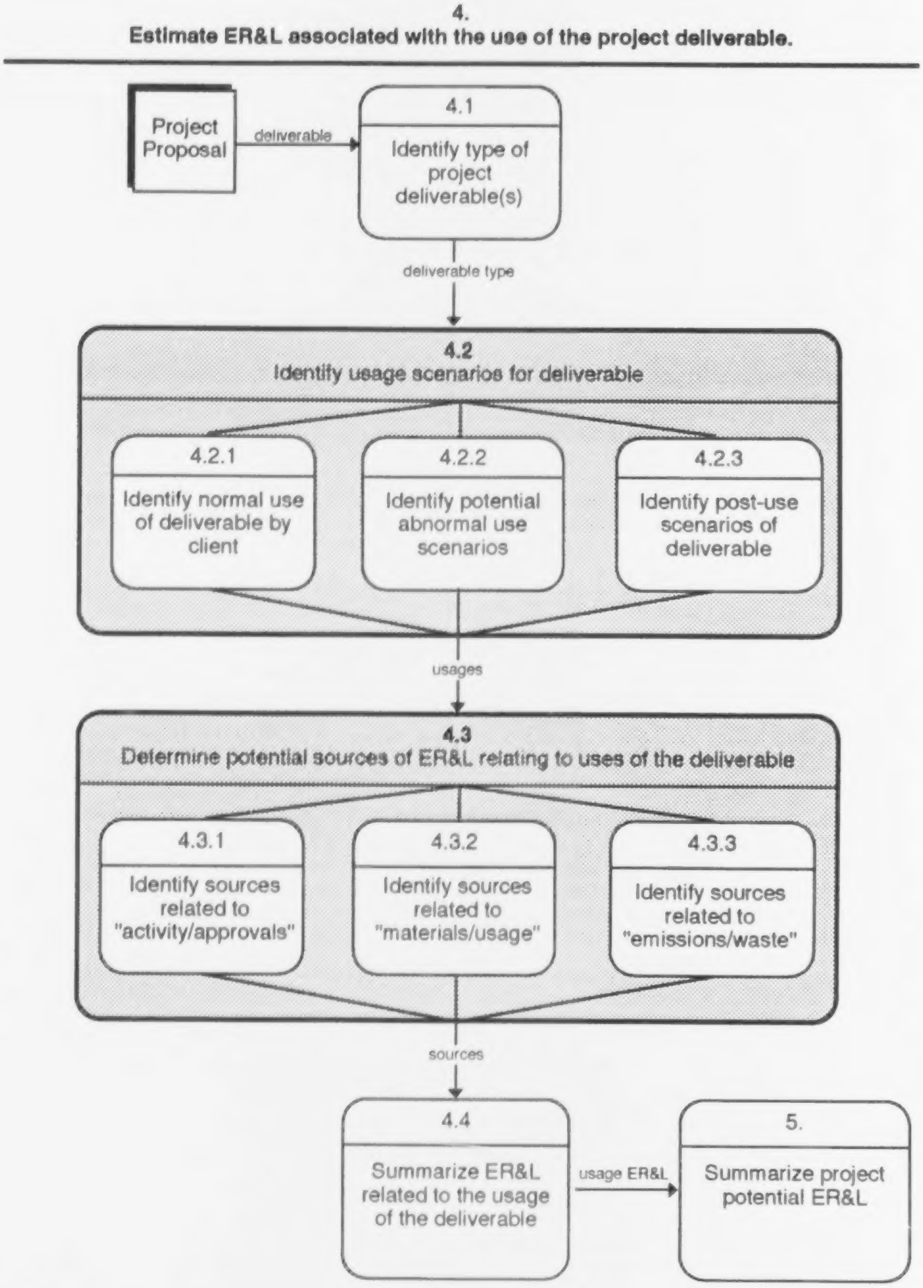
4.
Estimate ER&L associated with the use of the project deliverable.
Project Proposal
deliverable
4.1
Identify type of project deliverable(s)
deliverable type
4.2
Identify usage scenarios for deliverable
4.2.1
Identify normal use of deliverable by client
4.2.2
Identify potential abnormal use scenarios
4.2.3
Identify post-use scenarios of deliverable
usages
4.3
Determine potential sources of ER&L relating to uses of the deliverable
4.3.1
Identify sources related to "activity/approvals"
4.3.2
Identify sources related to "materials/usage"
4.3.3
Identify sources related to "emissions/waste"
sources
4.4
Summarize ER&L related to the usage of the deliverable
usage ER&L
5.
Summarize project potential ER&L

Figure 5.5 Exploded process map for the process: Estimating Environmental Risk & Liabilities associated with the client/partner's use of the project deliverable.

Deliverable Types

- Product
- Process/Methodology
- Report
- Software
- Data
- Technology

Figure 5.6 The classification scheme of project deliverables for the purpose of Process 4.

When determining usage of a deliverable, the term usage has three aspects:

- *normal use*, the intended use of the deliverable by the client/partner. Examples of normal use for different types of project deliverables is provided in Table 5.1. Note that this list of uses in not exhaustive;
- *abnormal use*, the unintended use of the deliverable, and includes things such as transportation accidents, malfunctions, and out-of-context use of information or data. Examples of abnormal use for different types of project deliverables is provided in Table 5.2. Again, this list of abnormal uses should not be considered exhaustive; and
- *post-use*, after the normal life use of the deliverable. Examples of post-use for different types of project deliverable are provided in Table 5.3, with the same provisions on the lists as Tables 5.1 and 5.2.

The usage scenarios assist in the identification of the sources of environmental risk and liability for the project deliverable in use (Subprocess 4.3). Again, by identifying the usage scenarios, the scope of relevant environmental risk and liability is narrowed. The sources of environmental risk and liability outlined in Process 3 are also used in this subprocess; the difference is that they are applied to each of the usage scenarios. In addition to the previously mentioned narrowing effect, this also has the effect of identifying where the project deliverable-in-use attracts the risk.

Table 5.1 Client/Partner **Normal** Uses of Project Deliverables

	Type of Project Deliverables					
	Product	**Process /Methodology**	**Report**	**Software**	**Data**	**Technology**
Uses	• produce or generate other product • acquire product from 3rd party for a novel use • use product within a process (end-user of product) • develop market for product • commericalize product	• produce a product • control output from another process • support decision-making • commericalize process	• support decision-making • reference	• support decision-making • develop other software • manage data and/or information • control processes • develop processes • provide advice	• support decision-making • develop interpretations	• develop a market for the technology • apply the technology to support a business • commericalize the technology

Table 5.2 Client/Partner **Abnormal** Use Scenarios of Project Deliverables

	Type of Project Deliverables					
	Product	**Process /Methodology**	**Report**	**Software**	**Data**	**Technology**
USES	• product malfunction • inappropriate use of product • transportation mishap	• process malfunction • inappropriate use of methodology	• inappropriate use of report	• program intervention • program malfunction "bugs"	• inappropriate use of data • QA/QC problems	• technology malfunciton • inappropriate use of technology

Table 5.3 Client/Partner **Post-Use** Scenarios of Project Deliverables

	Type of Project Deliverables					
	Product	**Process /Methodology**	**Report**	**Software**	**Data**	**Technology**
U S E S	• recycle • feedstock for another process or product • reuse by third party • waste/ultimate disposal	• process decommission	• obsolescence	• removal of software • obsolesence	• obsolescence	• technology decommission

5.3 Evaluation of the Process

The processes described in the preceding section are intended to:

- fulfill the corporate need to conduct its affairs in a manner that is considered to be environmentally responsible, by ensuring that due diligence with respect to project-related environmental concerns has been exercised and documented; and
- fulfill the project-staff need to have a system that does not place an inflexible burden on the project initiation process.

Evaluation of the environmental risk identification processes, therefore, needs to be done in a manner that determines whether or not the intended goals have been met.

An important element in the evaluation of the first goal is the concept/standard of due diligence. The standard for due diligence from a legal perspective requires that three elements be present: the use of reasonable care, a system in place, and procedures for ensuring that the system is working. A key principle underlying the standard is the concept of reasonableness and forseeability. This principle can also be used to evaluate applicability of the processes outlined in Section 5.2 towards the first stated goal: Can the processes be *reasonably* expected to identify *foreseeable* problems in sufficient clarity to allow for corrective action?

For the second stated goal, the constraints identified by workshop and interview participants (see Section 4.3) can be used to guide the evaluation of the processes. Of the constraints listed in Section 4.3, one of the most directive was: "avoid being bureaucratic, cumbersome, and onerous". A measure that would evaluate the processes with respect to this directive would be: Can the processes rapidly identify situations/projects where there are no reasonable and foreseeable environmental concerns?

To evaluate the processes, four case studies were chosen to represent the diverse nature of development activities within the research and technology development organization. A description of each case study is provided as Appendix 2. Within each case study, the evaluation needed to look at each of the major processes in turn, to see first if the reasonableness and forseeability criteria were met, and second if the process was able to identify "no concerns" when applicable. However, since the level of development for each of the processes was different, so must be the level or focus of the evaluation. The focus of the evaluation for Processes 1 and 2 was on what the expected outcome might be from the processes for each case study. Essentially, the evaluation of these two processes will identify what might be reasonable and foreseeable responses from the system. The focus of the evaluation for Processes 3 and 4 was on whether or not the reasonableness and foreseeability criteria, and the ability to identify "no concerns" criterion were met.

5.3.1 Process 1

The purpose for Process 1 is to estimate the environmental risks and liabilities for the organization as a result of the activities necessary to complete a project. What needs to be considered within this process are what factors determine different environmental risk and liability responses from "doing a project". By determining the factors that elicit different responses, the scenarios that generate the "no environmental concerns" response can be readily identified. Factors that should be considered within this process are: project activities and project facility requirements.

Addressing facilitates first, the different facilities that make up the organization's infrastructure will have different environmental risks and liabilities associated with them. In addition, the different activities that make up the project can have different facility requirements. Together, these two variables can be used to identify the potential environmental risks and liabilities for the organization, based on "doing" a project. The issues concerning activities–facility requirements for a project must also address "usage". For example, can the proposed activity be considered part of the normal use of the facility. If the activity is within the "normal" use of the facility, the environmental risk and liability of the project would be considered to be "covered" under the normal risk management plans of the organization. If the activity is not consider a normal use of the facility, then the environmental risks and liabilities need to be identified and addressed.

Using the case studies as examples (Figure 5.7), two of the case studies had activities that resulted in the normal use of the facilities. These projects therefore, had no environmental risk and liability beyond what would be normally be covered by the organization's risk management program. The

Process 1 : Evaluate ER&L arsising from "doing" the project					
		Sub-Processes			
Case Study		Determine type of activity proposed	Determine operational facility requirements for project	*System 1 assessment of project on operational infrastructure*	Report project impact on ARC infrastructure
1.	Automation of a window manufacturing facility	process redesign	client premises; office	*Normal use of infrastructure*	Normal
2.	Evaluation of a technology for increasing the dewatering rate of sludges	technology evaluation	analytical lab; research lab; field	*A.*	Sample/Material Handling & Management Concerns
3.	Pipeline scheduling joint venture	software development	office	*Normal use of infrastructure*	Normal
4.	Sampling program for pilot gravel washing project at Canada Creosote	field sampling and analytical work	analytical lab; office; field	*B.*	Sample/Material Handling & Management Concerns
Notes:					
A.	*Ensure appropriate transportation, storage, handling and disposal of sludge materials.*				
	Ensure appropriate training of staff involved in the above areas.				
B.	*Ensure appropriate transportation, storage, handling and disposal of creosote contaminated materials.*				
	Ensure appropriate training of staff involved in the project.				

Figure 5.7 Possible System 1 identified environmental risks and liabilities for the organization for each of the case studies.

other case studies, however, had activities that fell outside the normal use definition of the facilities, thus creating significant System 1 concerns. Both of these projects dealt with substances that required special handling and storage, had transportation issues, as well as staff training issues. Identification of these types of issues is necessary by the system in order that appropriate System 1 personnel can be mobilized to ensure that the project runs smoothly and does not result in an environmental incident.

These case studies point out issues that need to be addressed in order for this process to satisfy the criteria for the standard of due diligence. The following are tasks that would resolve these issues:

- completion of the process map;
- identification of the different types of "facilities" within the research and technology organization; and
- identification of the "normal use" activities for each facility type.

5.3.2 Process 2

A project brings with it one of several different types of business relationships. Different types of business relationships have different levels and types of environmental risk and liability. Part of what this process needs to do is identify these different types of business relationships and assess the risks for each. The types of business relationships represented by the case studies varied from joint research ventures with the organization in a position of influence (i.e., some level of control) over the client/partner, to fee-for-service

Process 2 : Evaluate ER&L arising from doing business with the proponent					
		Sub-Processes			
Case Study		Identify Business Relationship Type	System 2 Evaluation of ER&L	Report Business Relationship ER&L	
1.	Automation of a window manufacturing facility	Joint Research Venture	*In a postion of influence; more detailed evaluation recommended*	More detailed evaluation recommended	
2.	Evaluation of a technology for increasing the dewatering rate of sludges	Joint Venture	*In a postion of influence; more detailed evaluation recommended*	More detailed evaluation recommended	
3.	Pipeline scheduling joint venture	Joint Research Venture	*None*	None	
4.	Sampling program for pilot gravel washing project at Canada Creosote	fee for service contract	*None*	None	

Figure 5.8 Possible System 2 identified environmental risks and liabilities for the organization for each of the case studies.

contracts (Figure 5.8). This variation also spans the range in environmental risk and liability that can arise from a business relationship.

By more fully identifying the business relationship types and identifying when to delve into more detail about a client/partner's environmental practices this process should satisfy the reasonableness and forseeability criteria in the due diligence standard.

5.3.3 Process 3

The purpose of Process 3 is to estimate the sources of environmental risk and liability for the organization from the project deliverable itself. It is a two-part process. The first part of this process is focused on the identification of the deliverable – what exactly will the proposed project produce and what type of project deliverable is it? This first part addresses the need for the process to quickly identify project deliverables that have "no environmental concerns". The second part of the process is focused on the identification of the reasonable and foreseeable environmental risks and liabilities for the corporation based on the project deliverable. Questions to be considered at this stage reflect the information provided in the first stage. Examples of relevant questions/considerations for this stage of the process, based on deliverable "type", are provided as Figure 5.9. This main distinction for deliverable types for this process is whether or not the deliverable is a report. Any other deliverable is classified as a "thing".

	CONSIDERATIONS BY DELIVERABLE TYPE	
LIABILITY SOURCE	***"thing"***	***report***
Activity / Approvals	• is the deliverable an activity as defined by AEPEA? • compare deliverable to AEPEA definition of activity & Schedule of activities • consider requirements for approvals under AEPEA, CEPA, TDGA, and Fisheries Act	• if the evaluation includes a technology demonstration, the activity may require a permit/approval under AEPEA • consider requirements for approvals under AEPEA, CEPA, Fisheries Act
Materials / Usage	• is the deliverable: • a hazardous substance, • a "designated" material • a regulated chemical • a new substance • does the deliverable have materials that fall into these classifications? • consider requirements for reporting, notification, information, to employees, workers, regulatory bodies and government agencies (AEPEA, CEPA, WHMIS)	• consider legal requirements of the deliverable (NPRI, MSDS, etc.) • consider environmental consequences of material in the evaluation or recommendation of a material • data reports need to consider appropriateness of sampling techniques & methods, analytical methods and maintenance of chain of custody
Emissions / Wastes	• is the deliverable an emission or waste? • does the deliverable have emissions or wastes? • consider all emissions and waste streams • are any hazardous? • are any regulated?	• consider emission standards, guidelines, and regulations (AEPEA, CEPA, Fisheries Act) used to evaluate/recommend technology. • currency, appropriateness • consider all emissions and waste streams in the description, evaluation, or recommendation of a technology or product. • data reports need to consider appropriateness of sampling techniques & methods, analytical methods and maintenance of chain of custody

Figure 5.9 Considerations for identifying potential sources of environmental risk and liability for a project deliverable, using the deliverable type as a key.

Of the deliverable types, "things" have potentially both the highest and the lowest level environmental risk and liability. Turning to "reports", the risk level varies depending on the content of the report. Descriptive reports and those that are primarily reporting data, with no interpretation, potentially have the lowest risk level for a report. The risk level would tend to increase as the interpretive value of the report increases, first to providing evaluations and then to providing recommendations. There will, of course, be exceptions to this generalization.

The case studies used to evaluate this process had deliverables that spanned the range of deliverable types (Figure 5.10). Using the deliverable type as a key, the considerations provided in Figure 5.9 were applied to each case study to identify the environmental risks and liabilities for the organization based on project deliverables. As can be seen in Figure 5.10, the risk and liability levels varied from none for Case Study #3, to potential risk and liability in all liability source categories for Case Study #1. Note that for both of these case studies the deliverable type was "thing", thus confirming the position that the deliverable type "thing" can have the highest and the lowest risk levels. In addition, considering the details for Case Studies #1 and #3, the result obtained would be expected, reasonable, and foreseeable. Case Study #1's deliverable was an improved manufacturing system, whereas the deliverable for Case Study #3 was a software program. Looking at the other case studies, Case Studies #2 and #4 had as their deliverable types reports, specifically an evaluation report and a data report, respectively. The evaluation report,

		Case Study			
		#1	#2	#3	#4
	Deliverable:	improved manufacturing system	validation report	software	sampling program; data report
	Deliverable Type:	"thing"	report	"thing"	report
Liability Source	Activity / Approval	AEPEA Activity?; changes to processes and systems require reporting under AEPEA	▨	▨	▨
	Usage Water, Energy, Materials	using a wood preservative & compressed gases; appropriate MSDS, SOP's, training; NPRI requirements	▨	▨	Sampling program and data addressing hazardous substances
	Emission/Wastes	emissions include sawdust; dry garbage;packaging material; air emissions of VOC's	Consider all emissions & waste streams; concentration of substances in one phase as a result of process; Consider currency & appropriateness of standards used in evaluation	▨	Appropriate methods used for sampling, analysis and maintenance of chain of evidence; Characterize emissions/wastes to all media (air, water, solid)

Figure 5.10 Project deliverable environmental risks and liabilities for the organization from the case studies.

however, did not have a higher risk level than the data report. Reviewing the details for each of these case studies, this result is not unexpected. Case Study #4 dealt with a sampling and analysis exercise with creosote-contaminated materials, whereas Case Study #2 was validating claims for a sludge dewatering technology. The issues identified by the process are both valid and reasonable for both of these case studies.

This process appears to meet both the reasonableness and forseeability criteria for due diligence, and the "no concerns" criterion. Discussions with the project managers responsible for the case studies, also came to this same conclusion: that the process did identify reasonable and foreseeable environmental risks and liabilities for their projects, and was able to quickly identify "no concerns" when appropriate. The project managers did raise the concern about the "level" of detail that was required to complete the process. Some typical questions were:

- Where do you draw the line? and
- How far do you go?

In response to these concerns, a discussion of the concept of reasonable and foreseeable was extremely important. This process is not intended to find the subtle environmental consequences of a project deliverable. Its intention is to raise flags and point out the obvious (i.e., reasonable and foreseeable) environmental concerns that should be addressed by project managers.

5.3.4 Process 4

Process 4 has as its purpose the estimation of the sources of environmental risk and liability for the corporation as a result of a project deliverable being used. Like Process 3, Process 4 has two parts: first, the identification of reasonable and foreseeable usage scenarios for the project deliverable; and second, the identification of reasonable and foreseeable environmental risks and liabilities for the corporation, based on the usage scenarios. Obviously, an understanding of the concept of what is considered reasonable and foreseeable is extremely crucial to this process.

As mentioned previously, usage scenarios for a project deliverable will depend on what the project deliverable is. Examples of possible uses for different categories of project deliverables were presented as Tables 5.1 through 5.3. The normal, abnormal, and post-use scenarios for each of the case studies are included in their Process 4 evaluation summary matrix figures (Figures 5.11 through 5.14 for Case Studies #1 through #4, respectively).

Choosing relevant usage scenarios for a given project deliverable will depend on what is a reasonable and foreseeable use for the deliverable. Normal usage will generally be the easiest to identify, however, it may not at first seem obvious. Identification of post-use scenarios generally will be next in difficulty, with identification of abnormal usage scenarios generally the most difficult. Take, for example, Case Study #4 where the project deliverable was a data report (Figure 5.14). The project manager for this case study indicated that, at the time of the project, he hadn't given much thought to the use to which

Case Study #1 : Automation of a window manufacturing facility			
Deliverable: Improved manufacturing system	**Deliverable In Use ER&L**		
Liability Source	Normal Usage (production)	Abnormal Usage (production malfunction)	Post-Use (facility decomissioning)
Activity / Approval	▨	▨	decomissioning of a facility is an activity under AEPEA
Usage Water, Energy, Materials	▨	uncontrolled substance release; appropriate procedures in place; reporting requirements	remediation requirements as a result of using wood preservatives may be necessary
Emission/Wastes	separation of waste streams	spill material may be classified as a hazardous waste	▨

Figure 5.11 Summary of the process evaluation (Process 4) for case study #1.

Case Study #2 : Evaluation of a sludge dewatering technology			
Deliverable: Validation report	**Deliverable In Use ER&L**		
Liability Source	Normal Usage (marketing/promotion)	Abnormal Usage (out of context use)	Post-Use (dated conclusions)
Activity / Approval	Technology demonstration may require an AEPEA approval; evaluation may be used to support approval application	Evaluation may be used to support approval application for a direct implementation of process	▨
Usage Water, Energy, Materials	▨	▨	▨
Emission/Wastes	▨	Concentration of substances in one phase; Emission standards/guidelines used	▨

Figure 5.12 Summary of the process evaluation (Process 4) for case study #2.

Case Study #3 : Pipeline Scheduling JRV			
Deliverable: software	**Deliverable In Use ER&L**		
Liability Source	Normal Usage (give advice)	Abnormal Usage (s.ware bugs/h. intervention)	Post-Use (obsolesence)
Activity / Approval	▨	▨	▨
Usage Water, Energy, Materials	regulated material	uncontrolled regulated material release; large volumes of contaminated product	▨
Emission/Wastes	▨	▨	▨

Figure 5.13 Summary of the process evaluation (Process 4) for case study #3.

Case Study #4 : Sampling program for gravel washing pilot			
Deliverable: sampling program; data report	**Deliverable In Use ER&L**		
Liability Source	Normal Usage (process evaluation)	Abnormal Usage (out of context)	Post-Use (obsolete data)
Activity / Approval	Data to support approval application for emission/waste discharge (AEPEA, OHS, Municipality, Fisheries Act)	Data used selectively to support approval application for emission/waste discharge (AEPEA, OHS, Municipality, Fisheries Act)	▨
Usage Water, Energy, Materials	▨	▨	▨
Emission/Wastes	Data used for classification / assessment of waste streams (hazardous/non-hazardous); Determine disposal requirements (use of appropriate (and current) standards	Out of context use of data for support of waste classification decisions	▨

Figure 5.14 Summary of the process evaluation (Process 4) for case study #4.

the data he produced would be put. The client was doing the data interpretation, so it wasn't important to him, the project, or the organization. In responding to the request to identify the normal, abnormal and post usage scenarios for the project deliverable, the initial response for the normal usage was data interpretation, with no abnormal use or post-use for the data. However, after some thought, he realized that what the client actually did with the data was to support an approval application under the new AEPEA regulations. While the post-use scenario remained the same (data obsolescence), the abnormal use scenario changed remarkably. Taking data out of context, or using it in an inappropriate manner, was a reasonable abnormal use scenario for this project deliverable, and one that was also foreseeable.

The normal, abnormal, and post-use classification of usage scenarios, along with the liability source categories combine to provide a structure by which identification of environmental risk and liability for a deliverable-in-use can occur. This 3 x 3 matrix provides an efficient method for evaluation of the process with respect to the reasonableness and forseeability criteria in the due diligence standard. It also allows for the rapid determination of where there are "no environmental concerns" that are reasonable and foreseeable. As with Process 3, questions to be considered at this stage reflect the information provided in the first stage, essentially mapping the concerns into the evaluation matrix. Examples of relevant questions or considerations for this stage of the process are provided as Figure 5.15.

	CONSIDERATIONS
LIABILITY SOURCE	**Deliverable in Use**
Activity / Approvals	• consider requirements for approvals under AEPEA, CEPA, TDGA, and Fisheries Act • is the deliverable, in use, an activity? • does the deliverable, in use, modify an activity? • will the discontinued use of the deliverable modify an activity?
Materials / Usage	• consider materials consumed, modified, and/or generated by the deliverable in use. • does the deliverable, in use, use, modify, and/or generate materials that have been designated under legislation? • does the deliverable, in use, use, modify, and/or generate chemicals, and are the chemicals on a regulated list? • are hazardous substances being used? • consider the release of substances into the environment from chemical use and storage • consider establishment of appropriate on-site chemical management, training, and SOP's • consider energy requirements, energy source, & energy minimization • consider water requirements, quantity & quality, water minimization & alternatives
Emissions / Wastes	• consider emission standards, guidelines, and regulations (AEPEA, CEPA, Fisheries Act) • consider all emissions/wastes to air, water/liquid, and solid media • consider fugitive and controlled emissions • consider waste storage – requirements, substance release from storage (intentional, and unintentional) • are hazardous wastes being generated? • consider waste streams: – are they separated (promotion of recycling) – are technologies for pollution prevention and waste minimization being considered/used?

Figure 5.15 Considerations for identifying potential sources of environmental risk and liability for a deliverable-in-use.

The application of the process to the case studies was done two ways: either by workshop discussion with all participants, or by individual interviews with the project manager. The results of the application of the process to the case studies are provided as Figures 5.11 through 5.14. Since the case studies were chosen to reflect the diverse nature of the development activity within the research and technology development organization, it is not surprising that the results created were equally varied. There were some similarities in results, notably under the post-use scenario portion of the matrix. Three of the four case studies identified some form of obsolescence as a reasonable and foreseeable post-use scenario for the project deliverable. Not surprisingly, this post-use scenario did not have any environmental risk and liability concerns in any of the case studies. Concerns that were raised for each case study appear to be both relevant and valid. For example:

- case studies that involved the use of substances identified the uncontrolled release of the substance a concern under the abnormal use scenario (Case Studies #1 and #3);
- out of context use of information identified similar concerns for case studies that had this as an abnormal use scenario (Case Studies #2 and #4);
- the case study that was an activity under AEPEA identified several concerns around the post-use scenario of facility decommissioning (Case Study #1); and

- for most case studies, normal usage scenarios generated very few concerns. The exception here was Case Study #4, which was using data to support decision-making processes.

This process identified reasonable and foreseeable environmental risk and liability concerns for the case studies. It was also able to identify "no environmental concerns" where and when appropriate. As with Process 3, this process is not intended to find the subtle environmental consequences of a deliverable-in-use. The intention is to identify the obvious environmental issues and concerns that may arise as a result of using a project deliverable.

6. CONCLUSIONS

We currently live in a society that expects all organizations to conduct their affairs in an environmentally responsible manner. To fulfill this expectation, organizations require processes and tools that explicitly include the environment in decision-making and in day-to-day operational activities. Essentially "the environment" needs to be elevated to the same status as "economic" and "technical" concerns within organizations.

Interactions between the environment and a company's operations vary from company to company and across industrial sectors. The majority of organizations have development activity in an environment of preset boundaries, resulting in a domain of environmental concerns that is relatively static. The bulk of effort in establishing an EMS in this type of firm is focused on implementation. This does not apply to organizations, such as research and technology development organizations, that have development activities in an environment that has changing, undetermined boundaries. In this type of organization the EMS stage of diagnosis and definition is being continuously revisited. Optimization of this stage in the EMS is crucial to successful environmental risk management within this type of organization.

A system to optimize the EMS stage of diagnosis and definition in a research and technology development organization has:

- *components* (users, processes, and data);

- *elements* that determine the outcome of processes and define the fundamental relationships within the system; and
- *constraints* .

The components, elements and constraints fit together to define a set of inputs, outputs and processes that make up the system. The relationships between the various pieces of the overall system are demonstrated in Figure 6.1.

The focus of this work has been directed at only one component of the overall system; the process map. Specifically, the focus has been to develop the processes that provide the underlying logic to the system (the process map), using a "real" organization to provide a development environment that reflected practical and tangible business concerns. In order to develop the process map, several questions needed to be answered; first, on the subject of environmental risk and liability; and second, on the subject of an organization's environmental concern domain.

On the subject of environmental risk and liability, the questions took the following form:

- what constitutes an environmental risk or liability?
- what are the sources of the risks and liabilities? and
- how should the risk sources be structured to optimize and facilitate an identification process?

On the subject of an organization's environmental concern domain, the questions were:

- what causes the domain to change / when does it change?
- how are risks and liabilities generated by the agent of change?

The answers to these questions provided the information necessary to develop a logical model of the system processes.

In a research and technology development organization, because of the nature of the development activity, the domain of environmental concerns potentially will change with every project it undertakes. In turn, environmental risk and liability is generated by projects four different ways:

- by doing the project (i.e., the activities necessary to complete the project),
- through the relationship with the client/partner/business associate,
- from the outcome of the project (the project deliverable), and
- from the project deliverable in use, including normal, abnormal and post-use scenarios.

Each of these ways of generating risks has different risk issues, data requirements, and management strategies.

Turning to environmental risk and liability, the system of environmental law defines the sources of environmental risk and liability for an organization. It also defines both specific sources of environmental liability that may apply to the organization, and guiding principles around environmental matters. To facilitate the identification of environmental risk and liability for a given project, these sources can be structured into the following categories:

- sources relating to regulated activities and approvals,
- sources relating to materials and usage, and
- sources related to emissions and waste.

Together, the categories of environmental risk sources and the ways risks are generated from a project combine to provide an overall structure and model to the risk identification process (Figure 6.2). This model can be broken into four primary processes, one for each method a project has for generating environmental risk and liability. Two of the four processes were fully developed as part of this work (indicated by the shaded cells in Figure 6.2).

This process model is intended to identify environmental risks and liabilities that would be considered "reasonable" and "foreseeable" from a given project. This process model is not intended to identify environmental risks that are the result of low-probability extraordinary events, extreme negligence or gross incompetence. Events that fall into one of these categories are beyond the nature of reasonable and foreseeable and a reasonable interpretation of the concept of due diligence.

The proposed model also incorporates practical operational concerns from the test organization. Projects within the organization will generate a varying number of environmental risks and liabilities – from none, to several. This model allows the rapid determination of cases where the project will generate few to no environmental risks. It also indicates what in the project generates the risks and where it may impact the organization.

The applicability of the processes was tested using four case studies that represented the diverse nature of development activities within the test organization. The case studies generated varying environmental risks and liabilities across all model elements. The evaluation showed that the proposed process model:

- identified reasonable and foreseeable environmental risks and liabilities for a research and technology development organization from a project;
- provided a structure that determined what in a project generates the risk and where it may impact the organization; and
- provided a structure that permitted a project to consider only those environmental aspects that were relevant to the project.

This process model must be recognized as only one piece in a complete system for environmental due diligence (Figure 6.1). Work remains to be done to address development of the other system components. It's important to note that the information and data requirements of this system overlap with other, parallel business systems. To be fully operational, as well as efficient and effective, this proposed system for environmental due diligence will need to be incorporated and coordinated with these other business systems. With complete implementation, this proposed system will demonstrate that the research and technology development organization was:

- managing its environmental risks in a manner that can achieve "bottom line" benefits,

- increasing the value of its products,
- acting in a manner consistent with the environmental expectations of society.

An important component to the overall system are the individuals who will be using it. Within the test organization the primary users will be project managers. The proposed system will have an impact on how these individuals do the job of preparing and developing proposals. Steps will need to be taken and training devised that clearly indicate the benefits to the individual for complying with, and using the system. These individuals will need to recognize their personal and professional responsibility for practicing environmental due diligence, and that by using the proposed system:

- their project proposals are reviewed and approved in a prompt manner,
- their personal liability is being managed,
- their project deliverables have better value, and “after-project” costs are minimized, and
- personal knowledge level has increased, thereby increasing their own professional worth and marketability.

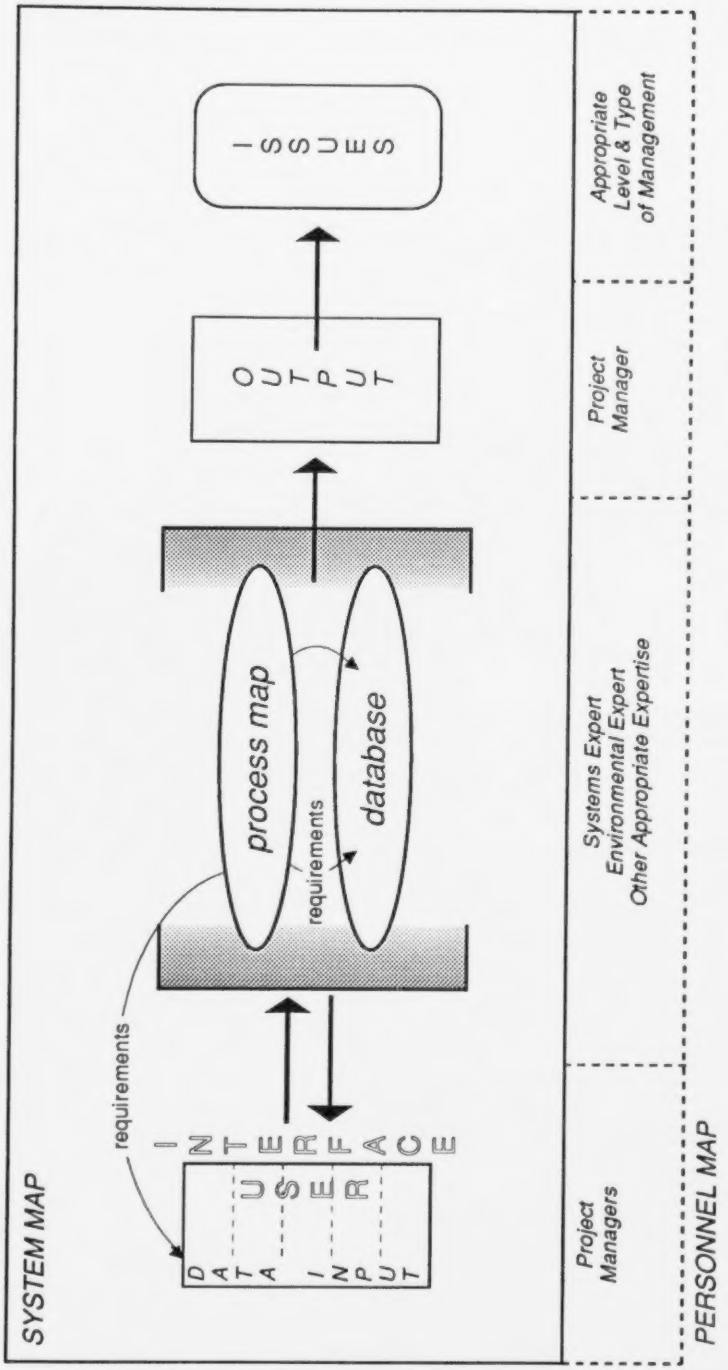

Figure 6.1 A map showing (1) the interactions between the different system components and (2) the interactions between personnel and the system components.

		Activities / Approvals	Material / Usage	Emissions / Waste
PROCESS 1	Doing			
PROCESS 2	Business Relationship			
PROCESS 3	Outcome (Deliverable)	▨	▨	▨
PROCESS 4	Deliverable in Use	▨	▨	▨

Figure 6.2 A simple logical model representing the processes required for environmental risk identification associated with a research and technology development organization's projects. The shaded cells depict the processes that were fully developed as a result of this work.

7. RECOMMENDATIONS

> "Try to change situations, not people"
>
> ...Trevor A. Kletz

The processes developed are only one part of a complete system to optimize the EMS stage of diagnosis and definition in a research and technology development organization. Further research and development work is required on the other parts of the system in order to make it operational. Using Figure 6.1 as a guide, the development needs and corresponding recommendations for future work can be classified into the following categories: Processes, Database, User Interface, and Issues.

Processes:

- Develop detailed logical process maps for Processes 1 and 2. Within the test organization, this will require the involvement of personnel from other EMS Systems, specifically Systems 1 (Internal Operations) and 2 (Business Relationships), respectively.
- Integration of environmental risk and liability identification model into the project initiation and evaluation activity within the organization. This activity addresses the need that this system for environmental due diligence must be incorporated and coordinated with other, parallel business systems within the organization.
- Define data requirements to support the process model and all detailed processes within it.

Database:

- Develop databases to address and fulfill the data requirements of the process model. Within the test organization this will involve incorporation of the databases into the corporate information infrastructure, and will involve personnel from other EMS Systems – specifically System 5 (Information Management System).

User Interface:

- Analyze system data requirements to generate a user-friendly interface. The intent here is to ask for information (a question) only once, while servicing the needs of all the EMS Systems within the organization, as well as the other, parallel business systems.
- Develop logic paths / project templates that efficiently discriminate situations (projects) with "no concerns" from situations where environmental risk and liabilities need to be considered.
- Develop input form/device.
- Develop training plans to educate employees on how to use the system and on the benefits that accrue to them by using it.

Issues:

- Develop an issue ranking scheme that translates the identified environmental risks into issues for management (i.e., what types of risks require what level of management attention). The concept is similar to a delegation or financial authorization pyramid.

- Develop a process to solicit environmental risk tolerance profiles of the organization and of the management within the organization. The environmental risk tolerance profile is only one aspect of an overall risk tolerance profile for the organization. It will need to developed with consideration of other types of risk tolerances within the organization (i.e., business financial risk). The process developed will also need to recognize that risk tolerance profiles are not static, that profiles will change as a result of a variety of factors. The process will also need to identify what the factors are that will result in a change in environmental risk tolerance profile for the individual and for the corporation.

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9. APPENDIX 1: ENVIRONMENTAL GUIDING PRINCIPLES – EXAMPLES OF ELEMENTS

International Chamber of Commerce (ICC)

Business Charter for Sustainable Development
Principles for Environmental Management

1. **Corporate Priority**
To recognize environmental management as among the highest corporate priorities and as a key determinant to sustainable development; to establish policies, programmes and practices for conducting operations in an environmentally sound manner.

2. **Integrated Management**
To integrate these policies, programmes and practices fully into each business as an essential element of management in all its functions.

3. **Process of Improvement**
To continue to improve policies, programmes and environmental performance, taking into account technical developments, scientific understanding, consumer needs and community expectations, with legal regulations as starting point; and to apply the same environmental criteria internationally.

4. **Employee Education**
To educate, train and motivate employees to conduct their activities in an environmentally responsible manner.

5. **Prior Assessment**
To assess environmental impacts before starting a new activity or project and before decommissioning a facility or leaving a site.

6. **Products and Services**
To develop and provide products or services that have no undue environmental impact and are safe in their intended use, that are efficient in their consumption of energy and natural resources, and that can be recycled, reused, or disposed of safely.

7. **Customer Advice**
To advise, and where relevant educate, customers, distributors, and the public in the safe use, transportation, storage and disposal of products provided; and to apply similar considerations to the provisions of services.

8. **Facilities and Operations**
To develop, design and operate facilities and conduct activities taking into consideration the efficient use of energy and materials, the sustainable use of renewable resources, the minimization of adverse environmental impact and waste generation, and the safe and

responsible disposal of residual wastes.

9. **Research**
To conduct or support research on the environmental impacts of raw materials, products, processes, emissions, and wastes associated with the enterprise and on the means of minimizing such adverse impacts.

10. **Precautionary Approach**
To modify the manufacture, marketing, or use of products or services or the conduct of activities, consistent with scientific and technical understanding, to prevent serious or irreversible environmental degradation.

11. **Contractors and Suppliers**
To promote the adoption of these principles by contractors acting on behalf of the enterprise, encouraging and, where appropriate, requiring improvements in their practices to make them consistent with those of the enterprise; and to encourage the wider adoption of these principles by suppliers.

12. **Emergency Preparedness**
To develop and maintain, where significant hazards exist, emergency preparedness plans in conjunction with the emergency services, relevant authorities and the local community, recognizing potential transboundary impacts.

13. **Transfer of Technology**
To contribute to the transfer of environmentally sound technology and management methods throughout the industrial and public sectors.

14. **Contributing to the Common Effect**
To contribute to the development of public policy and to business, governmental and intergovernmental programmes and educational initiatives that will enhance environmental awareness and protection.

15. **Openness to Concerns**
To foster openness and dialogue with employees and the public, anticipating and responding to their concerns about potential hazards and impacts of operations, products, wastes or services, including those of transboundary or global significance.

16. **Compliance and Reporting**
To measure environmental performance; to conduct regular environmental audits and assessments or compliance with company requirements, legal requirements and these principles; and periodically to provide appropriate information to the Board of Directors, shareholders, employees, the authorities and the public.

Coalition for Environmentally Responsible Economies (CERES) Principles (1992)

(formerly known as the Valdez Principles)

Protection of the Biosphere

We will reduce and make continual progress toward eliminating the release of any substance that may cause environmental damage to the air, water, or the earth or its inhabitants. We will safeguard all habitats affected by our operations and will protect open spaces and wilderness, while preserving biodiversity.

Sustainable Use of Natural Resources

We will make sustainable use of renewable natural resources, such as water, soils, and forests. We will conserve non-renewable natural resources through efficient use and careful planning.

Reduction and Disposal of Waste

We will reduce and where possible eliminate waste through source reduction and recycling. All waste will be handled and disposed of through safe and responsible methods.

Energy Conservation

We will conserve energy and improve the energy efficiency of our internal operations and of the goods and services we sell. We will make every effort to use environmentally safe and sustainable energy sources.

Risk Reduction

We will strive to minimize the environmental, health, and safety risks to our employees and the communities in which we operate through safe technologies, facilities and operating procedures, and by being prepared for emergencies.

Safe Products and Services

We will reduce and where possible eliminate the use, manufacture or sale of products and services that cause environmental damage or health or safety hazards. We will inform our customers of the environmental impacts of our products or services and try to correct unsafe use.

Environmental Restoration

We will promptly and responsibly correct conditions we have caused that endanger health, safety or the environment. to the extent feasible, we will redress injuries we have caused to persons or damage we have caused to the environment and will restore the environment.

Informing the Public

We will inform in a timely manner everyone who may be affected by conditions caused by our company that might endanger health, safety or the environment. We will regularly seek advice and counsel through dialogue with persons in communities near our facilities. We will not take any action against employees for reporting dangerous incidents or conditions to management or to appropriate authorities.

Management Commitment

We will implement these Principles and sustain a process that ensures that the Board of Directors and Chief Executive Officer are fully informed about pertinent environmental issues and are fully responsible for environmental policy. In selecting our Board of Directors, we will consider demonstrated environmental commitment as a factor.

Audits and Reports

We will conduct an annual self-evaluation of our progress in implementing these principles. We will support the timely creation of generally accepted environmental audit procedures. We will annually complete the CERES Report, which will be made available to the public.

Disclaimer

These principles establish an environmental ethic with criteria by which investors and others can assess the environmental performance of companies. Companies that sign these principles pledge to go voluntarily beyond the requirements of the law. These principles are not intended to create new legal liabilities, expand existing rights or obligations, waive legal defenses, or otherwise affect the legal position of any signatory company, and are not intended to be used against a signatory in any legal proceeding for any purpose.

Canadian Chemical Producer's Association (CCPA)

Responsible Care – Guiding Principles

Each member company has subscribed to the following guiding principles:

- Ensure that its operations do not present an unacceptable level of risk to employees, customers, the public or the environment.
- Provide relevant info on the hazards of chemicals to its customers, urging them to use and dispose of products in a safe manner, and make such information available to the public on request.
- Make responsible care an early and integral part of the planning process leading to new products, processes or plants.
- Increase the emphasis on the understanding of existing products and their uses, and ensure that a high level of understanding of new products and their potential hazards is achieved prior to and throughout commercial development.
- Comply with all legal requirements which affects its operations and products.
- Be responsive and sensitive to legitimate community concerns.
- Work actively with and assist governments and selected organizations to foster and encourage equitable and attainable standards.

Business Council on National Issues

Business Principles for a Sustainable and Competitive Future

1. Adopt sustainable development as a key operating principle of the company.
2. Develop corporate goals and objectives for sustainable development, and a means to measure progress against these objectives. Communicate periodically to the board, shareholders, employees, government authorities, and the public with respect to these goals and progress made.
3. Promote public policies and regulatory frameworks within which market forces can be fully responsive to the choices of individuals and organizations in working towards sustainable development.
4. Meet or exceed all applicable environmental laws, regulations and standards.
5. Before launching any new project, product or service, undertake an evaluation of its sustainability, and integrate into the planning process measures to prevent or minimize any potential environmental impact.
6. Adopt the principle of life cycle management by applying sustainability criteria at every stage of the enterprise's activity — from R&D, design for recycling and reuse, and the utilization of raw materials and hazardous substances, to production processes, transportation and distribution, sales and customer use, and ultimate disposal.
7. Take a proactive role in promoting the goal of sustainable development, both nationally and internationally, and work cooperatively with government, labour and public interest groups to develop policies to promote sustainable development practices by suppliers, customers, and others in the business community.
8. Consider means to facilitate the transfer of environmentally beneficial technologies, throughout the business sector and internationally, by the deployment of managerial, technical, and financial resources.

National Round Table on the Environment and the Economy (NRTEE)

Objectives for Sustainable Development

1. **Stewardship**
   We must preserve the capacity of the biosphere to evolve by managing our social and economic activities for the benefit of present and future generations.

2. **Shared Responsibility**
   Everyone share the responsibility for a sustainable society. All sectors must work towards this common purpose, with each being accountable for its decisions and actions, in a spirit of partnership and open cooperation.

3. **Prevention and Resilience**
   We must try to anticipate and prevent future problems by avoiding the negative environmental, economic, social and cultural impacts of policy, programs, decisions and development activities. Recognizing that there will always be environmental and other events which we cannot anticipate, we should also strive to increase social, economic and environmental resilience in the face of change.

4. **Conservation**
   We must maintain and enhance essential ecological processes, biological diversity and life support systems of our environment and natural resources.

5. **Energy and Resource Management**
   Overall, we must reduce the energy and resource content of growth, harvest renewable resources on a sustainable basis and make wise and efficient use of our non-renewable resources.

6. **Waste Management**
   We must first endeavour to reduce the production of waste then reuse, recycle and recover waste by-products of our industrial and domestic activities.

7. **Rehabilitation and Reclamation**
   Our future policies, programs and development must endeavour to rehabilitate and reclaim damaged environments.

8. **Scientific and Technological Innovation**
   We must support education and research and development of technologies, goods and services essential to maintaining environmental quality, social and cultural values and economic growth.

9. **International Responsibility**
   We must think globally when we act locally. Global responsibility requires ecological interdependence among provinces and nations, and

an obligation to accelerate the integration of environmental, social, cultural and economic goals. By working cooperatively within Canada and internationally, we can develop comprehensive and equitable solutions to problems.

10. Global Development
Canada should support methods that are consistent with the preceding objectives when assisting developing nations.

Keidanren (Japan Federation of Economic Organizations)

Keidanren Global Environment Charter
Guidelines for Corporate Action

1. General Management Policies

Companies should always carry on their business activities to contribute to the establishment of a new economic social system for realizing an environmentally protective society leading to sustainable development.

2. Corporate Organization

a. Companies shall establish an internal system to handle environmental issues by appointing an executive and creating an organization in charge of environmental problems.

b. Environmental regulation shall be established for company activities, and these shall be observed. Such internal regulations shall include goals for reducing the load on the environment. An internal inspection to determine how well the environmental regulations are being adhered to shall be carried out at least once a year.

3. Concern for the Environment

a. All company activities, beginning with siting of production facilities, shall be scientifically evaluated for their impact on the environment, and necessary counter-measures shall be implemented.

b. Care shall be taken in the research, design, and development stages of making a product to lessen the possible burden on the environment at each level of its production, distribution, appropriate use, and disposal.

c. Companies shall strictly observe all national and local laws and regulations of environmental protection, and where necessary they shall set additional standards of their own.

d. When procuring materials, including materials for production, companies shall endeavour to use resources efficiently and reduce waste products through recycling, and shall appropriately deal with pollutants and waste products.

4. Technology Development

a. In order to help solve global environmental problems, companies shall endeavour to develop and supply innovative technologies, products and services that allow conservation of energy and other resources together with preservation of the environment.

5. Technology Transfers

a. Companies shall seek appropriate means for the domestic and overseas transfer of their technologies, know-how and expertise for dealing with environmental problems and conserving energy and other resources.

b. In participating in official development assistance projects, companies shall carefully consider environmental and anti-pollution measures.

6. Emergency Measures

a. If environmental problems ever occur as a result of an accident in the course of company activities or deficiency in a product, companies shall adequately explain the situation to all concerned parties and take appropriate measures, using their technologies and human and other resources, to minimize the impact on the environment.

b. Even when a major disaster or environmental accident occurs outside of a company's responsibility, it shall still actively provide technological and other appropriate assistance.

7. Public Relations and Education

a. Companies shall actively publicize information and carry out educational activities concerning their measures for protecting the environment, maintaining ecosystems, and ensuring health and safety in their activities.

b. The employees shall be educated to understand the importance of daily close management to ensure the prevention of pollution and the conservation of energy and other resources.

c. Companies shall provide users with information of the appropriate use and disposal, including recycling, of their products.

8. Community Relations

a. As community members, companies shall actively participate in activities to preserve the community environment and support employees who engage in such activities on their own initiative.

b. Companies shall promote dialogue with people in all segments of society over operational issues and problems seeking to achieve mutual understanding and strengthen cooperative relations.

9. Overseas Operations

a. Companies developing operations overseas shall observe the Ten-Points-environmental Guidelines for the Japanese Enterprises Operating Abroad in Keidanren's Basic Views of the Global Environmental Problems.

10. Contribution to Public Policies

a. Companies shall work to provide information gained from their experiences to administrative authorities, international organizations, and other bodies formulating environmental policy, as well as participate in dialogue with such bodies, in order that more rational and effective policies can be formulated.

b. Companies shall draw on their experience to propose rational systems to administrative authorities and international organizations concerning formulation of environmental policies and to offer sensible advice to consumers on lifestyles.

11. Response to Global Problems

a. Companies shall cooperate in scientific research on the causes and effects of such problems as global warming and they shall also cooperate in the economic analysis of possible counter-measures.

b. Companies shall actively work to implement effective and rational measures to conserve energy and other resources even when such environmental problems have not been fully elucidated by science.

c. Companies shall play an active role when the private sector's help is sought to implement international environmental measures, including work to solve the problems of poverty and over-population in developing countries.

European Petroleum Industry Association (EUROPIA)

Environmental Guiding Principles

1. **Make** the principles set forth herein a high priority in the definition and implementation of corporate strategies.
2. **Adapt** where necessary internal procedures, industry practices and other operating guidelines towards the gal of protecting the environment and the health and safety of individuals.
3. **Conduct** operations and handle raw materials and products in a manner that protects the environment and the health and safety of employees and the public, while conserving natural resources and using energy efficiently.
4. **Develop** and maintain procedures to reduce the risk of spills or accidental emissions; maintain appropriate emergency response procedures in case of accidents.
5. **Develop** programmes to reduce overall emissions and waste generation.
6. **Ensure** that adequate waste management programmes are developed and carried out, which will allow the disposal of wastes as safely as is reasonably practicable.
7. **Work** with others to resolve problems arising out of the handling and disposal of hazardous substances from members' operations.
8. **Provide** advice to customers, contractors or others on the safe use, handling, transportation and disposal of raw materials, products and wastes from members' operations.
9. **Inform** appropriate officials, employees, customers, and the public in a timely manner on significant industry-related safety, health and environmental hazards, and recommend protective measures.
10. **Support** research and development programmes to study the effects of the industry's activities on the environment, the health and safety to individuals and the prevention of the risks connected hereto.
11. **Promote** among employees and individual and collective sense of responsibility for the preservation of the environment and protection of health and safety of individuals.
12. **Work** and consult with authorities drafting laws, regulations or procedures to safeguard the community, work place and environment.
13. **Promote** these principles and practices by sharing experiences and offering technical assistance to others who deal with similar raw materials, petroleum products and wastes.

10. APPENDIX 2: CASE STUDIES

10.1 Case Study #1

Title: Automation of a window manufacturing facility for increased production capability and export potential

Project Summary: To develop a manufacturing system that was:

- flexible with respect to volume and new products,
- a flow-through system,
- used Just-In-Time (JIT) principles,
- used computer integrated manufacturing (CIM) process, and
- allowed for continuous improvement

To develop a computer-based information system that:

- allowed one-point order entry, and
- linked and controlled all aspects of the business.

Considerations:

- environmental assessment should be considered on-going and iterative
- decision points in current process should incorporate check
  - have any environmental issues surfaced?
- individually responsible
- process should be explicit, increase awareness and knowledge

10.2 Case Study #2

Title:	Evaluation of a technology for increasing the dewatering rate of sludges
Project Summary:	Testing and validation of the technology performance claims for sludge dewatering. The technology uses a brief intense electric arc to create a shock wave in the liquid causes suspended particles in the liquid to form clumps.

Considerations:

- consider all phases/waste streams (liquid and solid) in the evaluation (re: ask scientifically-responsible questions)
- currency of emission standards used in evaluation
- purpose of evaluation (how used)

10.3 Case Study #3

Title:	Pipeline Scheduling Joint Venture
Project Summary:	To develop software to assist in the scheduling of oil and liquid gas in pipelines.

Considerations:

- is the software in a control loop?
- is the human in the loop?
- how much reliance is placed on the software?
- does the software result in a significant change to existing process? Is the process in a regulated activity?
- degree and faithfulness of replication
- result of override; foreseeability of override action resulting negative environmental consequence

10.4 Case Study #4

Title: Sampling program for pilot gravel washing project at Canada Creosote

Project Summary: Conduct sampling and provide data report to evaluate the effectiveness of the treatment process and to evaluate the environmental impact of the treatment process

Considerations:

- reliance on information supplied for decision-making
- ownership and stewardship of materials
  - bringing the problem to our premises (transportation, handling, storage, and disposal of hazardous materials
  - control of samples
  - rigour of sampling and analytical methods
- connection and interface to internal systems